Bay-Delta Water Quality Evaluation
Draft Final Report

California Urban Water Agencies

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Preface by **California Urban Water Agencies**

One objective of the CALFED Bay-Delta Program is to provide good water quality in water diverted from the Delta to meet drinking water needs. To accomplish this, CALFED must select a long-term solution that provides a quality of source water that urban water providers can treat with reasonable cost to meet current and future federal and state health-based drinking water standards. To enable a quantitative assessment of the impact of alternative Bay-Delta solutions, specific water quality criteria must be chosen for analysis. Although there are numerous water quality constituents of concern in meeting drinking water standards, the major constituents of health concern in Delta water are pathogens (*Giardia* and *Cryptosporidium*) and disinfection by-product (DBP) precursors (bromide and total organic carbon). The quality of water diverted from the Delta will bear heavily on the treatment technology which needs to be employed to meet increasingly stringent drinking water standards. Municipal water providers are already investing hundreds of millions of dollars in advanced treatment processes to meet more restrictive treatment standards. Without a higher quality of source water, probable future standards could make these investments obsolete and force technology which can neither be guaranteed to perform, be feasible due to market constraints or environmental regulation constraints, or be realistically affordable to the end users.

Setting water quality criteria requires knowledge about both the future regulatory setting under the Safe Drinking Water Act and the relative performance characteristics of currently available treatment technologies under a variety of actual conditions. Rather than asking its treatment experts to make this assessment, CUWA convened a panel of nationally recognized drinking water quality experts to determine the required criteria for total organic carbon (TOC) and bromide that will allow utilities treating Delta water to comply with current and probable future drinking water regulations utilizing available advanced technology. The expert panel consists of Douglas Owen, P.E. Vice President at Malcolm Pirnie, Inc., Phillippe Daniel, P.E. Associate at Camp Dresser & McKee and R. Scott Summers, PhD, Associate Professor at the University of Cincinnati. The purpose of the expert panel report is to recommend Delta drinking water quality criteria with which CALFED staff can evaluate Bay-Delta alternative's relative performance in meeting program objectives. These criteria have been developed in recognition of the interaction between source water quality, treatment efficacy and probable regulatory outcomes, as developed by the panel. This report, however, does not represent CUWA's or any of its members endorsement of a specific regulatory outcome.

This report concludes that for currently available advanced water treatment technology (i.e., enhanced coagulation and ozone disinfection) to be able to meet potential long-term drinking water quality standards for water diverted from the Delta, the source water quality should have concentrations less than 3.0 mg/L for TOC and less than 50 μg/L for bromide (<20 mg/L chloride concentration). Although using granular activated carbon or membranes allows upward flexibility in these values, the feasibility of these processes in terms of cost,

residual disposal, and construction is uncertain (there are only one or two facilities in the United States of the size applicable to CUWA member facilities which use GAC or membranes for drinking water treatment). Source water quality with concentrations higher than 3.0 mg/L TOC and 50 μg/L bromide could still meet a near-term regulatory scenario, but the long-term scenario is more appropriate for planning eventual CALFED Bay-Delta solution.

CUWA recognizes that based upon historic concentrations of these constituents measured at Clifton Court Forebay in the Delta, it is unlikely that the above criterion for bromide could be met by all urban water agencies using ozonation under existing conditions, even in wet years. Therefore, CALFED must carefully analyze a variety of actions within its alternatives analysis to determine which combination of actions can assure the achievement of the program's drinking water quality objective in concert with other important objectives. These actions should include at least the following:

- The capability of in-Delta hydraulic modifications to limit seawater intrusion and resulting increase in bromide concentration
- Pollutant source control programs for TOC and pathogens (actions should include areas where water is degraded after diversion from the Delta as well as the Bay-Delta watershed itself.)
- Water storage and storage management
- Increased outflow
- An isolated facility

These actions must be assessed in appropriate combinations designed to meet CALFED's multiple program objectives.

CUWA also recognizes that CALFED should assess the environmental and economic impact and the practical feasibility of **not** providing a water quality for Delta diversions which would allow future standards to be met with currently available advanced technology. CUWA does not believe such technology, including membrane technologies and granulated activated carbon filtration, are either affordable or feasible on the scale needed for municipal treatment in California and are not likely to be in the foreseeable future.

Public water agencies have a unique public trust responsibility to provide the highest quality of water reasonably achievable. This approach to public health protection is one that is balanced by combining (1) source selection to enhance water quality, (2) source protection to preserve water quality, and (3) effective and reliable treatment technology. CUWA believes the CALFED Bay-Delta Program solution should be consistent with the following principles.

- Maintenance and improvement of existing high quality urban water supplies and in-Delta supplies as the most effective means to protect public health

- A strong program of water pollutant source control is required to assure public health and environmental quality

- Provision for the highest quality drinking water quality reasonably available. This will assure the greatest likelihood that available treatment technologies will meet future drinking water standards.

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EXECUTIVE SUMMARY

The California Urban Water Agencies (CUWA) retained the assistance of three water quality and treatment specialists who have specific expertise in the formation of disinfection by-products (DBPs). These three individuals -- the expert panel -- evaluated specific source water quality characteristics which would be necessary to permit diverted water from the San Francisco Bay/Sacramento-San Joaquin River Delta (Delta) to be used for meeting potential public health related water quality standards under defined treatment conditions. Specifically, the expert panel was charged with 1) developing potential future regulatory scenarios, 2) defining appropriate process criteria for coagulation, ozonation, granular activated carbon and membrane treatment processes, and 3) estimating source water quality diverted from the Delta which would allow users implementing the defined treatment technologies to comply with the regulatory scenario. The source water quality characteristics were framed in the context of total organic carbon (TOC) and bromide concentrations, both constituents which have the potential to be controlled by different management strategies for the Delta.

Two potential regulatory scenarios were projected based upon regulatory negotiations conducted in 1992-93 and 1997. The near-term scenario focuses on Stage 1 of the Disinfectant/Disinfection By-Product (D/DBP) Rule and the Interim Enhanced Surface Water Treatment Rule. The long-term scenario focuses on Stage 2 of the D/DBP Rule and the Long Term Enhanced Surface Water Treatment Rule. The potential regulatory scenarios include specific limits for two organic classifications of DBPs recently proposed in rulemaking by EPA; total trihalomethanes (TTHMs) and the sum of five haloacetic acids (HAA5). In addition, a potential limit was projected for bromate, an inorganic by-product formed by the ozonation of bromide-containing waters; a standard has been proposed by EPA for this DBP, as well. These DBP limits were coupled with various potential requirements for microbial removal and inactivation.

The treatment criteria specified by the expert panel for the near-term regulatory scenario included: 1) the use of 40 mg/L of alum at a pH of 7.0 and possibly as low as 6.5 in the coagulation process, followed by chlorine disinfection with a chloramine residual in the distribution system, and 2) the use of ozone at specific ozone:TOC ratios followed by a chloramine residual. The chlorine and ozone disinfection criteria were proposed to meet potential 1 or 2 log *Giardia* inactivation requirements. For the long-term regulatory scenario, the use of post-filter GAC adsorbers, GAC in combination with ozone, membrane filtration in combination with ozone, and nanofiltration with free chlorine were considered. The long-term scenario included inactivation for *Giardia* and *Cryptosporidium*, the latter of which could only be achieved by ozone disinfection or the "absolute barrier" of membrane treatment.

The expert panel used data submitted by CUWA members, available literature and ongoing research, as well as their own experience and best professional judgement to arrive at potential source water quality requirements. Available models for DBP formation were evaluated to investigate threshold DBP formation behavior and to support the initial conclusions reached by the expert panel.

Specific combinations for TOC and bromide necessary in the water diverted from the Delta can vary depending upon the treatment technology implemented and microbiological inactivation required. Further, the selected bromate level of 5 μg/L in the long-term regulatory scenario is significant in establishing limiting bromide levels in this evaluation. The rationale for this level in this analysis ultimately may be modified by a variety of factors including allowing for trade-offs for disinfection and the formation of organically-based brominated DBPs (e.g., THMs or HAAs) or evidence of a cancer threshold for bromate (investigations underway). On the other hand, there are other potential regulatory outcomes involving 1) further lowering the MCLs for DBPs, 2) the regulation of individual DBP species (rather than the groups of compounds represented by TTHM and HAA5 due to the potentially more severe health effects associated with brominated compounds), 3) regulating other DBPs beyond TTHMs and HAA5, including the addition of other regulated HAAs (there are nine total) as analytical methods are developed and refined, 4) a comparative risk framework which balances all of the risk attributable to the DBPs formed, rather than providing specific MCLs for each group, and 5) concerns over reproductive and developmental effects that may be associated with DBPs, which may lower the regulatory levels and/or the permissible maximum concentration (i.e., annual averaging may no longer be the basis for determining compliance).

In summary, it was the opinion of the panel that < 3 mg/L of TOC and < 50 μg/L of bromide would be necessary to allow users the flexibility to incorporate either enhanced coagulation or ozone disinfection to meet the potential long-term regulatory scenario in this evaluation. The TOC value is constrained by the formation of total trihalomethanes when using enhanced coagulation for TOC removal and free chlorine to inactivate *Giardia*. The bromide value is constrained by the formation of bromate when using ozone to inactivate *Cryptosporidium*. Looking only at the potential near-term regulatory scenario provides significantly more source water flexibility when using enhanced coagulation or ozone, with source water TOC concentrations ranging between 4 and up to 7 mg/L (the 90th percentile value for waters diverted from the south Delta) and bromide ranging between 100 and 300 μg/L, depending upon the extent of *Giardia* inactivation required (the near-term scenario does not include *Cryptosporidium* inactivation).

Similarly, the use of either GAC or membrane treatment in the long-term regulatory scenario broadens the allowable source water quality. For GAC, a source water TOC value of 5 mg/L is acceptable with bromide of 150 μg/L or 50 μg/L, depending upon *Giardia* inactivation. GAC alone is not applicable to instances in which *Cryptosporidium* inactivation is required, and must be coupled with ozone disinfection. This allows the source water TOC concentration to increase to at least 7 mg/L, although bromide is constrained to < 50 μg/L even at an ozone pH of 6.5.

The use of microfiltration or ultrafiltration, coupled with ozone for primary disinfection and chloramines for secondary disinfection, is an "absolute barrier" for protozoan (*Giardia* and *Cryptosporidium*) removal. Viruses, however, must still be inactivated. This treatment scheme allows source water TOC concentrations to increase to at least 7 mg/L. The bromide concentration is again limited by bromate formation under ozone addition for virus inactivation, and is < 150 μg/L for microfiltration and < 300 μg/L for ultrafiltration (less virus inactivation is required for ultrafiltration). If nanofiltration is used with free chlorination, TOC concentration can be up to 10 mg/L for all bromide concentrations evaluated (< 300 μg/L).

It is important to note that when ozone disinfection is used for treatment, the allowable TOC is not unlimited. There are concerns regarding the ability of biological filters or GAC to remove biodegradable organic carbon to adequate levels as TOC approaches 7 mg/L (the 90th percentile for water diverted from the south Delta). In general, ozone disinfection is more effective and reliable as TOC decreases.

The feasibility of implementing either GAC or NF/RO membranes in California, given cost considerations, environmental permitting constraints, and limited residual disposal options, is uncertain. The use of MF/UF membranes address some residual disposal issues, but large system design issues affect feasibility on a site-specific basis.

1.0 INTRODUCTION

The California Urban Water Agencies (CUWA) engaged the services of three water quality experts to assist in providing input to the CALFED process regarding potential management alternatives in the San Francisco Bay/Sacramento-San Joaquin River Delta (Delta). The expert panel was charged with determining the required raw water quality diverted from the Delta which would permit the effective implementation of specific drinking water treatment processes to meet potential future drinking water quality standards. The expert panel was comprised of Douglas M. Owen, P.E., Vice President at Malcolm Pirnie, Inc., Phillippe A. Daniel, P.E., Associate at Camp, Dresser & McKee, and R. Scott Summers, PhD, Associate Professor at the University of Cincinnati.

The expert panel used data submitted by CUWA members, available literature and ongoing research, as well as their own experience and best professional judgement to arrive at potential source water quality requirements. Available models for DBP formation were evaluated to investigate threshold DBP formation behavior and to support the preliminary conclusions reached by the expert panel. This report presents the best professional judgement from this expert panel.

This report is subdivided into the following chapters:

Chapter 2 - Potential Regulatory Scenario and Schedule

Chapter 3 - Treatment Processes to Meet Regulatory Requirements

Chapter 4 - Evaluation of Source Water Quality and Treatment Efficiency

In Chapter 2, the general trends in drinking water regulations are discussed and plausible, future regulatory criteria are presented. Treatment processes relevant to users of water diverted from the Delta are presented in Chapter 3, together with general assumptions regarding the design and application of these processes. In Chapter 4, source water quality is projected which allows the treatment processes defined in Chapter 3 to be used to meet the potential regulatory scenario presented in Chapter 2.

2.0 POTENTIAL REGULATORY SCENARIO AND SCHEDULE

2.1 REGULATORY SCENARIO

2.1.1 Introduction

From a perspective of water quality parameters which can be controlled through management strategies in the Delta [e.g., total organic carbon (TOC) and bromide], the most critical present and future human health-related regulations affecting the implementation and performance of drinking water treatment processes for agencies using Delta water are:

1. Microbiological control - The focus for disinfection and microbial control currently pivots around the removal and inactivation of *Giardia* and *Cryptosporidium*. Currently, 3 log (99.9 percent) removal and inactivation of *Giardia* is required in the Surface Water Treatment Rule (SWTR). The EPA began considering an Enhanced SWTR (ESWTR) starting in late 1992, which would address the ability of systems to maintain microbiological control as disinfection practices were scrutinized. This rule would also address the removal/ inactivation of *Cryptosporidium*, through either removal or inactivation. The ESWTR has been proposed in two stages (USEPA, 1994) and is currently being re-evaluated, as discussed below.

2. Disinfection By-Product Control - The disinfectant residual concentration and the organic and inorganic compounds formed by the disinfection process (termed disinfection by-products or DBPs) will be regulated under the Disinfectants/Disinfection By-Products (D/DBP) Rule. This rule also was proposed in two stages (USEPA, 1994) and is currently being re-evaluated.

Other water quality contaminants, such as pesticides, herbicides, and metals, are of concern but are not likely to constrain treatment requirements as significantly as the microbial and DBP regulations, based upon their occurrence in water currently diverted from the Delta.

Both stages of the ESWTR and D/DBP Rule will impact the CUWA members and will affect the quality of water diverted from the Delta to meet regulatory requirements using an array of treatment technologies. Although a longer-term view of the regulations (i.e., second stage) is more appropriate to coordinate with the ultimate Delta management solutions, these future regulations are still relatively uncertain. The initial regulations -- Stage 1 of the D/DBP Rule and the Interim ESWTR — have been agreed to in principle

through a Federal Advisory Committee Act (FACA) process involving stakeholder meetings held in the Spring and Summer of 1997. Consequently, the expert panel evaluated potential future source water quality requirements using the specified technologies for both the near-term and long-term regulations.

The following sections discuss potential regulatory scenarios for both the near-term (i.e., Stage 1 D/DBP Rule and Interim ESWTR) and the long-term (i.e., Stage 2 D/DBP Rule and Long Term 2 ESWTR) regulations. Source water quality requirements are developed in Chapter 4, using the defined technologies in Chapter 3, to meet both the near-term and long-term potential regulatory outcomes.

2.1.2 Potential Near-Term Regulatory Scenario

Stage 1 D/DBP Rule

The requirements for the Stage 1 D/DBP Rule have been agreed to in principle through the FACA process. The requirements most significantly impacting treatment technologies and source water quality requirements include maximum contaminant levels (MCLs) and a treatment technique. Relevant MCLs include an 80 μg/L standard for total trihalomethanes (TTHMs) and 60 μg/L value for the sum of five haloacetic acids (HAA5). In addition, a 10 μg/L MCL has been proposed for bromate (a compound formed in bromide-containing waters, particularly with ozone treatment).

The treatment technique is enhanced coagulation and enhanced precipitative softening. For the CUWA members, the requirements of enhanced coagulation are more relevant than those for softening. With a few exceptions based upon treated water quality, enhanced coagulation must be implemented at existing conventional treatment facilities. It will not be enforced for direct filtration facilities. The treatment requirements for enhanced coagulation, as they apply to this evaluation, are discussed in Chapter 3.

Interim ESWTR

The Interim ESWTR (IESWTR), also agreed to in principle at the FACA negotiations, is designed to provide microbial protection as systems are potentially modifying treatment practices to comply with Stage 1 of the D/DBP Rule. In summary, the IESWTR focuses on maintaining the level of chemical disinfection currently provided at

existing facilities, while requiring a higher standard of particle removal. Briefly, the standard for combined filtered water turbidity will be reduced to <0.3 NTU at least 95% of the time. Individual filter turbidities must be monitored and there is a series of evaluations which must be performed if individual filter water turbidities exceed 1 or 2 NTU for consecutive 15 minute measurements.

The chemical disinfection requirements are based upon a microbial "backstop." In concept, the backstop focuses on maintaining the minimum level of disinfection that existing facilities have historically been providing. If a system modifies disinfection practices to meet the requirements of Stage 1 of the D/DBP Rule, they must either 1) meet or exceed the "backstop" disinfection practice, or 2) discuss their proposed disinfection modifications with the primacy agency (e.g., California Department of Health Services). The backstop is calculated through profiling existing disinfection practices as follows:

1. The monthly average of daily *Giardia* inactivation is calculated for three consecutive calendar years.

2. The minimum monthly average inactivation is identified for each calendar year.

3. The three minimum monthly average inactivations are averaged to calculate a single, "backstop" value.

This backstop is only applicable if a significant change in disinfection (e.g., disinfectant type, dosage) is implemented by the system which results in an inactivation that is less than the backstop value. It is important to note that the backstop triggers a discussion with the primacy agency. It is possible that the utility may be allowed to reduce the level of disinfection below the backstop level, depending upon the backstop value, disinfectant type, and other site-specific issues. The final disinfection requirements, if less than the backstop, are determined by the primacy agency together with the utility.

Historical disinfection data submitted by the Metropolitan Water District of Southern California and the Alameda County Water District were reviewed to determine a "central tendency" backstop for the CUWA members. The evaluation indicated that the backstop value could vary between 90 percent (1 log) and 99 percent (2 log) inactivation of *Giardia*.

Therefore, the expert panel considered both of these backstop values in determining source water quality requirements.

Potential Near-Term Regulatory Scenario

Based upon the above discussion, the potential near-term regulatory scenario is summarized in Table 2.1:

TABLE 2.1

POTENTIAL NEAR-TERM REGULATORY SCENARIO

Regulation	Parameter	Treatment Requirement or MCL
Interim ESWTR	*Giardia*	Additional 1 or 2 log inactivation by disinfection, after treatment removal credit
Stage 1 D/DBP Rule	TTHMs	80 μg/L
	HAA5	60 μg/L
	Bromate	10 μg/L

2.1.3 Potential Long-Term Regulatory Scenario

Stage 2 D/DBP Rule

Stage 2 DBP levels which were proposed in 1994, while acknowledged to be "placeholder" values until additional data can be collected and reviewed, were assumed to be reasonable targets for this analysis (i.e., TTHM of 40 μg/L, HAA5 of 30 μg/L). Further, a bromate MCL of 5 μg/L was considered for the long-term. The rational for this level is based upon a host of factors. First, the 10^{-4}, 10^{-5}, and 10^{-6} excess cancer risk levels for bromate are 5 μg/L, 0.5 μg/L and 0.05 μg/L, respectively. These levels were confirmed in EPA's recent Notice of Data Availability for Disinfectants and Disinfection By-Products in March 1998 (USEPA, 1998). Although a 5 μg/L limit was considered during the regulatory negotiation in 1992-1993, a value of 10 μg/L was established based upon practical quantitation levels (PQLs) for this compound at that time. Since 1994, however, many improvements have been made in the analytical technique for bromate thereby providing an excellent potential for reducing the PQL in future rulemaking. Because of EPA's reaffirmation of the carcinogenicity of bromate in recent studies and the improvement in analytical techniques, a bromate target of 5 μg/L was selected for the long-term scenario.

Long-Term ESWTR

The final outcome for a Long Term 2 ESWTR (LT2ESWTR) is uncertain, but many alternatives in the ESWTR proposed by EPA require treatment based on pathogen density in source waters (USEPA, 1994). Based upon 1) a review of pathogen data collected at various locations in the Delta by the Metropolitan Water District of Southern California, and 2) regulatory alternatives proposed in the ESWTR, plausible requirements identified by the expert panel for Delta water range from 1 log and 2 log inactivation of *Giardia* to 1 log inactivation of *Cryptosporidium*. This level of inactivation would be required after treatment removal credit is achieved. These criteria assume that higher log inactivations will be required as the concentration of pathogens in the source water increases. For every log increase in source water concentration, an additional log increase in removal/inactivation is required to achieve a constant finished water quality. This concept was proposed in the SWTR Guidance Manual and was furthered in several proposals published by EPA for the ESWTR.

Potential Long-Term Regulatory Scenario

Based upon the above discussion, the potential long-term regulatory scenario is summarized in Table 2.2:

TABLE 2.2

POTENTIAL LONG-TERM REGULATORY SCENARIO

Regulation	Parameter	Treatment Requirement or MCL
Long-Term 2 ESWTR	*Giardia*	Additional 1 or 2 log inactivation by disinfection, after treatment removal credit
	Cryptosporidium	Additional 1 log inactivation by disinfection, after treatment removal credit
Stage 2 D/DBP Rule	TTHMs	40 μg/L
	HAA5	30 μg/L
	Bromate	5 μg/L

While there are many factors that contribute to the uncertainty surrounding the projected regulatory scenario in Table 2.2, it is the selected bromate level of 5 μg/L that most keenly influences the analysis. The rationale for this level (i.e., advances in detection limit, the weight of the carcinogenic evidence, the precedence for THM and HAA5 limits in Stage 2 at half the Stage 1 levels) in this analysis could ultimately be modified by a variety of factors. Nevertheless, in the absence of more definitive direction, the panel considers a 5 μg/L value to be both prudent and plausible.

There are other potential regulatory outcomes involving 1) further lowering the MCLs for DBPs, 2) the regulation of individual DBP species (rather than the groups of compounds represented by TTHM and HAA5 due to the potentially more severe health effects associated with brominated compounds), 3) regulating other DBPs beyond TTHMs and HAA5, including the addition of other HAAs (there are nine total) as analytical methods are developed and refined, 4) a comparative risk framework which balances all of the risk attributable to the DBPs formed, rather than providing specific MCLs for each group, and 5) concerns over reproductive and developmental effects that may be associated with DBPs, which may lower the regulatory levels and/or the permissible maximum concentration (i.e., annual averaging may no longer be the basis for determining compliance). The potential implications of such regulatory outcomes is briefly discussed in Section 4.4.

2.2 REGULATORY SCHEDULE

The recently-enacted 1996 Amendments to the Safe Drinking Water Act (SDWA) have caused EPA to adopt a more ambitious schedule than EPA presented in June 1996 (see Table 2.3). The June 1996 dates were based upon a scenario in which EPA would not be "pushed" to develop an Interim ESWTR, and promulgate Stage 1 of the D/DBP Rule and the Interim ESWTR, until pathogen data were available from the Information Collection Rule (ICR).

TABLE 2.3

COMPARISON OF OLD AND NEW REGULATORY SCHEDULE

Regulation	Promulgation Date	
	Initial (June 1996)	Revised (August 1996)
Interim ESWTR	June 2000	November 1998
Long Term 2 ESWTR	NA (1)	November 2000
Stage 1 D/DBP Rule	June 2000	November 1998
Stage 2 D/DBP Rule	June 2003	May 2002

Notes:
(1) NA = Not available

EPA understands, however, that the LT2ESWTR and Stage 2 of the D/DBP Rule, at a minimum, are linked to data availability through the ICR. Monitoring for the 18-month ICR began in July 1997. Consequently, EPA was pressed between the statutory requirements and the recognition that a longer time frame would be required to promulgate Stage 1 of the D/DBP Rule and the IESWTR if the ICR data were to be considered. Therefore, EPA proceeded with interim regulations for microbial and DBP control based upon the existing knowledge base rather than waiting for the ICR data. The FACA process for the agreement in principle concluded in June 1997 to allow EPA to meet the schedule in Table 2.3 for the near-term regulations. Nevertheless, both the LT2ESWTR and Stage 2 of the D/DBP Rule will ultimately need to be finalized and become effective by the dates given in the reauthorized SDWA (November 2000 and May 2002, respectively) and take the ICR data into account. Even though the ICR monitoring has begun, the schedule will remain tight as a result of the time needed to analyze the data and to perform treatability studies to support compliance forecasts for the Stage 2 D/DBP Rule.

3.0 TREATMENT PROCESSES REQUIRED TO MEET FUTURE REGULATIONS

In this chapter, general process criteria are defined to characterize specific treatment processes relevant to users of water diverted from the Delta. Source water quality is determined in Chapter 4 which permits these treatment processes to meet the potential regulatory scenarios discussed in Chapter 2.

3.1 SELECTION OF TREATMENT PROCESSES TO BE EVALUATED

As a part of this effort, CUWA requested that the expert panel initially focus on those treatment processes which were considered to be the most cost-effective for simultaneously meeting the requirements of the D/DBP Rule and the ESWTR when treating water diverted from the Delta. These processes were defined as enhanced coagulation, a treatment technique proposed for Stage 1 of the D/DBP Rule, and ozone disinfection. These two processes are also relevant for Stage 2 of the D/DBP Rule and were considered appropriate because they can be implemented into facilities currently owned and operated by the CUWA agencies (as well as a majority of conventional filtration facilities across the country). For example, the majority of filtration systems across the country use conventional treatment including sedimentation, which allows for increased coagulation dosages to meet proposed enhanced coagulation requirements. In addition, some CUWA facilities already use ozone disinfection. The most cost-effective option(s) for meeting potential future regulations is specific for each water purveyor, depending upon water source and quality.

Based upon comments received from the Natural Resources Defense Council (NRDC), CUWA also directed the expert panel to evaluate the impact of implementing post-filter granular activated carbon (GAC) adsorbers and membranes on the potential allowable source water quality characteristics. Neither of these processes are currently used by any of the CUWA members and their feasibility for large scale water treatment facilities in California is uncertain. Post-filter GAC adsorbers and membranes can be at least an order of magnitude more expensive than ozone and the feasibility of these technologies is much more uncertain based upon cost, environmental permitting constraints, and availability of

residual handling alternatives. This view is shared by much of the water industry. For reference, only one or two treatment plants in the country at the size comparable to many of the CUWA members use post-filter GAC or membranes for drinking water treatment.

There are CUWA members who now treat much higher quality water than that currently diverted from the Delta. These entities are able to use in-line filtration or simply disinfection without filtration to produce high quality drinking water. It should be emphasized that the determination of feasible treatment processes is dependent upon the existing source and that this evaluation is based only upon those entities currently using water diverted from the Delta.

3.2 GENERAL ASSUMPTIONS FOR SELECTED TREATMENT PROCESSES

3.2.1 Enhanced Coagulation

Enhanced coagulation offers the advantages of removing naturally-occurring organic material, thereby removing DBP precursors which, upon disinfection, form DBPs. As such, MCLs for TTHMs and HAA5 can be addressed by enhanced coagulation, when followed by chlorine disinfection. Upon review of the potential for DBP formation, it was determined that enhanced coagulation would only be required under conditions in which free chlorine is used for primary disinfection (pathogen inactivation), followed by chloramines for secondary disinfection to maintain a distribution system residual. Further, this treatment option is only applicable to instances in which either 1 or 2 log *Giardia* inactivation is required to demonstrate microbial control, as discussed in Chapter 2. It was assumed that *Cryptosporidium* inactivation could not be achieved by free chlorine disinfection under treatment conditions feasible for drinking water systems.

The conditions for enhanced coagulation were defined according to the specific percent removal requirements for Total Organic Carbon (TOC) -- as proposed in Stage 1 of the D/DBP Rule (USEPA, 1994) and amended through the FACA process -- by raw water TOC and alkalinity. Given the specific TOC removal percentages in the proposed D/DBP Rule, this translated to a projected 40 mg/L dosage of alum at a coagulation pH of 7.0, and possibly as low as 6.5. Consequently, acid addition may be required since the 40 mg/L

dosage will likely only lower the pH to a value between 7.0 and 7.2. These coagulant dosages are not atypical of those currently being used by some CUWA members (e.g., Alameda County, Contra Costa, and Santa Clara Valley Water Districts), although these systems do not reduce pH with acid to improve precursor removal. It was assumed that a chlorine: TOC ratio of 1:1 and 60 minutes of free chlorine contact (t_{50}) would be required to achieve 1 log inactivation of *Giardia.* For 2 log *Giardia* inactivation, 120 minutes of free chlorine contact would be required. The above criteria for chlorine dose and contact time assume a chlorine residual of approximately 1 to 1.5 mg/L after the associated contact time, with a t_{10}:t_{50} ratio of between 0.5 and 0.6 in a moderately well-baffled contactor. This allows for the appropriate CT values to be met at the limiting case of a temperature between 10 and 15° C and a chlorination pH of 7.0 to 7.5. The 1 and 2 log *Giardia* inactivation targets are applicable to both the backstop for the IESWTR and some of the microbial requirements for the LT2ESWTR in the potential regulatory scenarios in Chapter 2.

In the above definition, it is assumed that chlorination would be postponed until after coagulation, flocculation and sedimentation is complete. It is recognized that during the latest round of regulatory deliberations, the USEPA accepted that utilities may need to provide raw water chlorination -- and receive credit for microbial inactivation -- simultaneously with removing organic material to reduce DBP formation. Recent enhanced coagulation research (Summers, 1997) indicates that the DBPs formed when chlorination is delayed until after sedimentation may be only 75 to 80 percent of those formed when prechlorination is practiced. Consequently, the definition of enhanced coagulation used in this evaluation represents the best that systems could achieve in terms of DBP production. This translates to a larger allowable range for source water quality. In addition, the above definition assumes that the systems can and will construct additional dedicated contact chambers to meet inactivation requirements, if required. There are costs associated with providing additional clearwell contact time beyond that currently available.

In the evaluation in Chapter 4, regions of "uncertainty" are illustrated to delineate those source water conditions under which the selection of specific treatment technologies will be highly system-specific. For enhanced coagulation, these regions will include the uncertainty associated with potential differences in DBP formation based upon whether or not prechlorination is practiced under enhanced coagulation conditions.

3.2.2 Ozone Disinfection

The use of ozone disinfection offers the opportunity to meet the MCLs for TTHM and HAA5 in the potential regulatory scenario by again using chloramines as the secondary disinfectant. Therefore, additional removal of naturally-occurring organic matter may not be necessary. That is, enhanced coagulation may not have to be coupled with ozone disinfection, as long as the source water TOC is $\leq$ 4.0 mg/L and alkalinity is > 60 mg/L as $CaCO_3$. Implementing ozone and chloramines under the Stage 1 timeframe to meet both Stage 1 and Stage 2 MCLs is one strategy for water utilities to avoid implementing enhanced coagulation when treating source waters with TOC concentrations $\leq$ 4.0 mg/L and alkalinity > 60 mg/L as $CaCO_3$. Many entities using water diverted from the Delta, however, treat source water TOC concentrations > 4 mg/L.

Based upon the ozone dosage and inactivation data from the CUWA members, the expert panel's experience, and recent research, possible ozone: TOC ratios which may be required to achieve pathogen inactivation were evaluated. These ratios take into consideration a host of factors, including 1) CT requirements for 1 log *Cryptosporidium* inactivation may be up to 10 times that required for 1 log *Giardia* inactivation, 2) ozone residuals increase as dosages increase for a fixed contact time once the initial ozone demand has been satisfied, and 3) pH affects the persistence of ozone residuals. The ratios were adjusted for pH effects (i.e., greater ozone residual persistence as pH decreases resulting in lower ozone requirements). For example, to meet 1 log *Giardia* inactivation at ambient pH, Alameda County Water District routinely requires an ozone to TOC ratio of 0.8 (ambient pH for entities using water diverted from the Delta can range from 7.5 to 9.5, a "typical" value of 7.8 is used in this analysis). At pH 7, MWD's demonstration plant results indicated roughly a 0.7 ozone: TOC ratio for achieving 2 log *Giardia* inactivation. It is important to note that CT compliance needs to be achieved continuously, and therefore an approximate

20 percent safety factor was applied to the CUWA member data. This also partially accounts for EPA's approach in setting CT values based upon 90 percentile values versus median (50 percentile values) which are represented by the CUWA member data. The selection of ozone: TOC ratios also considered operational issues, for which it was assumed that there would be a certain "overshoot" of specific dosage targets to ensure continual CT compliance. Based upon these assumptions, bromate formation was evaluated at a range of ozone: TOC ratios and pH values, as summarized in Table 3.1.

TABLE 3.1

OZONE: TOC RATIO AND PH CONDITIONS FOR BROMATE EVALUATION

pH	Ozone: TOC Ratios
7.8	0.8, 1.2, 1.5
7.2	0.7, 1.0, 1.3
6.8	0.6, 0.9, 1.1
6.5	0.5, 0.75, 1.0

The ozone: TOC ratios at each pH were considered to inactivate 1 log *Giardia*, 2 log *Giardia*, and 1 log *Cryptosporidium*. The 1 and 2 log *Giardia* inactivation is relevant to both the potential near and long-term regulatory scenarios presented in Chapter 2. The 1 log *Cryptosporidium* inactivation is only relevant to the LT2ESWTR in the potential regulatory scenario in Chapter 2.

It is recognized that the above ozone:TOC ratios are dependent upon other ozone design criteria proposed, such as a 12 minute contact time in a single, multi-chamber contactor. Other facility configurations, such as two-stage ozonation (e.g., ozone added at raw and settled water) and longer ozone contact times may yield different source water quality constraints for a fixed water quality target (e.g., bromate MCL). The criteria proposed here are based upon typical ozone system designs throughout the country.

The expert panel was also requested to evaluate bromate formation at pH 6.0. Relatively fewer data are available at this pH, and this value is outside the boundary conditions of available models (Ozekin, 1994) that were used to assist in validating the expert panel's initial opinions. Further, very few systems with moderate to high alkalinity

(> 60 to 80 mg/L as $CaCO_3$) would consider providing treatment at a pH of 6.0. It has a significant impact on chemical (acid) feed requirements to reduce pH which, in turn, have secondary impacts. For example, total dissolved solids (TDS) levels can increase significantly as a result of acid addition to achieve a pH of 6.0 in moderate to high alkalinity waters. A pH of 6.0 is also very aggressive to basin and pipe surfaces, and special precautions should be implemented in the design and construction of facilities to accommodate this pH.

It is the relative lack of data, however, that led the expert panel to not predict bromate production at a pH of 6.0. Any bromate concentration predicted at this pH would be speculative in nature, and would have a much greater uncertainty than other values presented in this report. Consequently, predictions of bromate formation at pH 6.0 are not presented.

3.2.3 Granular Activated Carbon Adsorption

Post-Filter GAC

Like enhanced coagulation, granular activated carbon controls the formation of DBPs through the removal of DBP precursors. Initially, GAC can remove over 80 percent of the organic DBP precursors. It is an unsteady-state process, however, in which the effluent concentration increases with time and the GAC has a finite adsorption capacity. Thus, when the effluent treatment objective is exceeded the GAC must be removed from the adsorbers and reactivated or replaced. The critical design parameter is the empty bed contact time (EBCT), which is the ratio of the volume of GAC to the volumetric flow rate. The critical operational parameter is the reactivation time or run time to the controlling effluent treatment objective. For the control of DBP precursors, typically measured as TOC, design EBCTs of 15 to 30 minutes are used and the GAC is operated until the effluent concentration (C) reaches 30 to 70 percent of that in the influent (C_0). The EBCTs are chosen so that the reactivation periods are at least 60 days. More frequent removal/reactivation of the GAC is expensive and limits feasibility from an operational perspective.

GAC is normally applied after the coagulation/sedimentation process and was assumed to follow rapid media filtration for this evaluation (post-filter adsorption mode). A GAC influent TOC range of 3 to 7 mg/L was evaluated and Table 3.2 lists the resulting effluent TOC concentration values for a range of breakthrough ratios (C/C_0).

TABLE 3.2

PREDICTED GAC EFFLUENT QUALITY FOR A RANGE OF INFLUENT TOC CONCENTRATIONS

Influent TOC (mg/L)	Effluent TOC (mg/L)		
	$C/C_0 = 0.3$	$C/C_0 = 0.5$	$C/C_0 = 0.7$
3	0.9	1.5	2.0
4	1.2	2.0	2.8
5	1.5	2.5	3.5
6	2.8	3.0	4.2
7	2.1	3.5	4.9

The same disinfection assumptions that applied to enhanced coagulation are also applicable to post-GAC microbial inactivation (i.e., a 1:1 chlorine to TOC dose ratio, 60 and 120 minutes of free chlorine contact to yield 1 and 2 log *Giardia* inactivation, respectively; free chlorine followed by chloramines for distribution system residual; no *Cryptosporidium* inactivation with this chlorine/chloramine combination).

Ozone and GAC Treatment

It is important to note that GAC, by itself, will not remove pathogens. Therefore, some systems, particularly in Europe, use GAC following ozone disinfection. In this configuration, ozone provides a strong disinfectant and the GAC is used to control biodegradable ozonation by-products through biological activity and to remove precursors of chlorination/chloramination by-products through adsorption. Many of the biodegradable ozonation by-products can be completely removed, and depending on the EBCT and water quality conditions, the biodegradable organic carbon (BDOC) can be decreased to the levels in the water prior to ozonation. GAC has not been shown to be efficient, however, for removing bromate using feasible design criteria in full-scale applications. This is discussed in greater detail in Section 4.2.2.

Following ozone, GAC can be used in a steady-state mode where the GAC is replaced at a very low frequency (once every 3 to 10 years) and a 20 to 30 percent removal of DBP precursors can be expected. In an unsteady state mode, as described above, the GAC is replaced more often (more than once per year) in which higher removal (30 to 70 percent) of DBP precursors can be expected. In this evaluation of ozone and GAC, ozone is expected to provide inactivation of *Cryptosporidium*, and chloramines will be applied after the GAC to provide a distribution system residual. A free chlorine contact time of 5 minutes was assumed sufficient to provide post-GAC inactivation of heterotrophic plate count bacteria, prior to the application of ammonia.

In this evaluation, it was assumed that the ozone and GAC act somewhat independently for the inactivation and removal of water quality contaminants. For example, ozone can be used to inactivate *Cryptosporidium*; GAC does not appreciably remove microbial contaminants. Ozone forms bromate; GAC does not adsorb bromate in feasible full-scale applications. Ozone does not remove precursors for organically-based DBP compounds (THMs and HAAs); GAC adsorbs these compounds. It is recognized, however, that ozone creates biodegradable organic components which can be adsorbed by GAC, thereby reducing the DBP formation potential through biodegradation. The amount of this removal compared to direct adsorption of organic material is relatively small and within the error of the estimates projected by the expert panel for GAC adsorption, alone.

3.2.4 Membrane Treatment

For simplicity, membrane treatment is divided into two categories in this evaluation:

1. Membrane filtration (e.g., microfiltration, ultrafiltration), which removes particles, protozoan cysts (*Giardia* and *Cryptosporidium*), and some viruses. Membrane filtration does not remove dissolved organic material, hardness, or ionic compounds (e.g., bromide) to any significant degree.

2. Membrane softening (e.g., nanofiltration, reverse osmosis), which removes particles, protozoan cysts, dissolved organic carbon, hardness, viruses and some ions (e.g., bromide). These "tighter" membranes must be preceded by particle removal to reduce fouling. Recently, the use of nanofiltration and reverse osmosis for dissolved organic carbon removal is challenging the traditional use for softening. RO membranes provide more complete rejection of salt (e.g., chloride bromide) than NF membranes.

Membrane filtration and membrane softening differ in many aspects. In general, capital costs for membrane softening are at least twice those for membrane filtration and much higher operating pressures are required for membrane softening (80 to 200 psi) as compared to membrane filters (15 to 30 psi). Therefore, the higher quality water produced by membrane softening comes at a price.

Membrane Filtration

Membrane filtration is being evaluated in a wide array of drinking water applications. The largest facility with an operating history in the United States is a 5 mgd facility in San Jose, CA. Larger facilities are under design, construction, and are being put on-line. Design of a 28 mgd facility is underway with planned operation in 2000 in Del Rio, Texas. Nevertheless, the use of membrane filtration for large plants (> 40 to 50 mgd) has not been demonstrated and the feasibility is uncertain. Most MF/UF installations showing demonstrated performance have modular units in the 1 to 1.5 mgd capacity range. Therefore, large plants require a large number of treatment modules, which significantly increases facility complexity.

The major advantage of membrane filtration is that, in the absence of coagulation, it does not produce a chemically-treated waste product. Consequently waste disposal is simpler. Further, the cost of membrane filtration is competitive with complete conventional treatment. The feasibility of membrane filtration, however, is dependent upon the source water. It performs best on low turbidity waters and waters low in TOC. Because membrane filters do not remove dissolved compounds, additional pretreatment (i.e., coagulation, flocculation and possibly sedimentation or flotation) must precede this technology if removal of organic carbon is necessary. This may reduce the cost efficiency of membrane filtration compared to conventional treatment.

Because membrane filters do not remove TOC or bromide, and because some virus inactivation still is required after treatment, the use of ozone disinfection followed by a chloramine residual in the distribution system will allow for the maximum flexibility in source water quality diverted from the Delta. In this evaluation, it was assumed that microfilter (MF) or ultrafilter (UF) membranes would follow existing, conventional sedimentation. Assuming 1 log and 2 log virus removal credits for sedimentation coupled

with MF and UF, respectively, additional 3 log (MF) and 2 log (UF) virus inactivations will be required by ozone to meet regulatory requirements. The CT requirements for 1 and 2 log virus inactivation by ozone are similar to that required for 0.5 log and 1.5 log *Giardia* inactivation, respectively. Therefore, bromate formation still is a concern using a membrane filtration/ozone/chloramine treatment strategy. Consequently, it was assumed that an ozonation pH of 6.5 would be required to maximize the flexibility in source water bromide concentrations diverted from the Delta.

Instead of using ozone, it is possible to use free chlorine following MF or UF to provide virus inactivation. The use of chlorine, however, introduces source water limitations based upon TTHM and HAA5 concentrations. Consequently, ozone was evaluated for disinfection rather than free chlorination following membranes. In addition, it may be possible to demonstrate a 4 log virus removal using UF, thereby eliminating any need for supplemental primary disinfection. This would have to be demonstrated to the satisfaction of the primacy agency.

Membrane Softening for DOC and Bromide Removal

There are a few membrane softening plants used for potable water treatment throughout the country, mostly in Florida. The largest membrane softening application for drinking water in the United States is 12 mgd. Slightly larger facilities have been constructed for groundwater recharge in California.

NF/RO membrane provides distinct advantages compared to MF/UF in that microbial contaminants (*Giardia, Cryptosporidium* and some viruses), dissolved organic carbon and bromide are all removed. There are two major issues which affect the feasibility of NF/RO membrane treatment in California. One is the disposal of membrane concentrate and the other is the volume of concentrate "wasted" from the system, which is much larger than that "wasted" by MF/UF systems. In a water-short regions such as California, the reject of 15 percent of the source water volume may be considered unacceptable. Further, this reject is highly concentrated with dissolved ions, and therefore disposal options, other than the ocean (if this can be environmentally permitted) are limited. Consequently, these considerations must be carefully weighed when determining whether it is feasible to implement NF/RO treatment.

For softening membranes, it is assumed that existing conventional treatment available at the CUWA treatment facilities, followed by cartridge filters, will provide sufficient pretreatment. Research and full-scale operations suggest that NF treatment can achieve at least 90 and 50 percent removal of TOC and bromide, respectively. It is recognized that RO could provide even higher levels of bromide removal (up to 90 percent), but NF was used as the limiting case in this evaluation. Further, it was assumed that membranes would be treating the entire flow. It is recognized that many facilities by-pass a portion of the membrane influent to achieve a target value for specific parameters (e.g., total dissolved solids) to lower costs and reduce corrosivity. This refinement, however, is beyond the scope of this effort as the extent of blending desired is site-specific.

Application of NF/RO is considered in combination with post-membrane chlorination for both primary and secondary disinfection in this evaluation because of the generally good quality (low TOC and TDS) of the treated water. Uniform formation conditions (UFC) were used to simulate the distribution system conditions (Summers et al., 1996); 24 hour contact time, pH 8.0, temperature of 20° C and a free chlorine residual of 1 mg/L after 24 hours.

3.3 CONCEPTUAL UNIT COSTS FOR TECHNOLOGIES

The technologies presented in this chapter have unique capital and operation and maintenance (O & M) costs. In this section, conceptual unit costs for specific technologies are provided. The estimates show a range of incremental costs, on a $/acre-ft (AF) basis (e.g., the increased unit cost for water treatment), for enhanced coagulation, ozone disinfection, granular activated carbon (GAC), membrane filtration (MF/UF), and membrane softening (NF/RO).

A range is provided to demonstrate that there is a spectrum of costs associated with a given technology, which is highly dependent upon factors such as design criteria, system size, and other site-specific factors. It must be emphasized that the costs presented here are incremental costs, and do not include costs for other aspects of treatment. For example, the membrane treatment costs do not include pretreatment, which will be considerable for NF/RO treatment. It is possible that conventional treatment including filtration can provide

adequate pretreatment for NF/RO, but the consistency of the pretreated water is critical for the success of the NF/RO technology.

The range of costs presented are based upon the expert panel's experience with systems around the country and are consistent with costs prepared for the USEPA during their development of the D/DBP Rule. These technology costs were peer-reviewed during the regulatory negotiation in 1992-1993 and were deemed acceptable by water industry representatives. Further, the costs were updated for the 1997 deliberations, and membrane costs were modified to reflect the substantial improvements in technology since 1992.

The expert panel did not generate independent cost estimates for CUWA members, as such costs are extremely site-specific and such an evaluation is not with the scope of this effort. The costs presented in this Section were compared to costs developed by the Metropolitan Water District of Southern California for all technologies, with the exception of membrane filtration. When Metropolitan's estimates are converted to unit costs ($/AF), the values fall within the range of costs presented here.

Table 3.3 provides unit costs for the technologies on a $/AF basis. These conceptual costs include amortized capital costs (e.g., 20 year design period, 8 percent interest) added to annual O & M costs. Again, these costs assume treatment of the entire facility flow, without bypassing and blending.

Table 3.3

Conceptual Incremental Unit Cost Treatment

Treatment	Incremental Cost $/Ac-Ft
Enhanced Coagulation	16-34
Ozone	26-42
Granular Activated Carbon	100-210
MF/UF Membranes	140-250
NF/RO Membranes	340-650

It is important to note that costs for controlling pH are not provided in the above table. These costs are highly site-specific but can add $5 to $10/Ac-Ft to incremental costs. In addition, it is important to reemphasize that all incremental costs are highly dependent upon many site-specific factors. A sample of potential factors affecting costs is presented in Table 3.4.

Table 3.4

Some Factors Affecting Incremental Treatment Costs

Technology	Example Factors Affecting Incremental Costs
Enhanced Coagulation	1. System size 2. Existing coagulant dosage 3. Required Coagulant dosage/pH 4. Existing and feasible sludge disposal method
Ozonation	1. System size 2. Oxygen feed source 3. Ozone dosage and pH conditions 4. Energy costs
Granular Activated Carbon	1. System size 2. GAC reactivation frequency 3. Method of reactivation/replacement 4. Energy costs
MF/UF Treatment	1. System size 2. Operating philosophy 3. System configuration 4. Backwash disposal
NF/RO Treatment	1. System size 2. Operating philosophy 3. Energy costs 4. Concentrate disposal option

4.0 EVALUATION OF SOURCE WATER QUALITY AND TREATMENT EFFICIENCY

4.1 WATER QUALITY IMPACTS AND VARIABILITY

In this section, water quality constraints are described which will allow implementation of specific treatment processes to meet potential regulatory goals. In general, the water quality constraints will be described in terms of two measurable surrogate parameters which affect DBP formation; TOC and bromide. In evaluating these water quality variables and interpreting the results, it is important to recognize that:

1. TOC is a heterogeneous mixture, and is comprised of humic and fulvic acids and other naturally-occurring organic material which varies from source to source and from location to location within a source. Consequently, TOC from different regions of the Delta will not have an identical impact on DBP formation. In this effort, it was necessary to assume that TOC could be a unifying variable for organic DBP precursor material, even given the inherent variability in the material which comprises this parameter.

2. The extent to which bromide participates in DBP reactions is dependent upon its oxidation state as well as its relative concentration with other competing oxidants (e.g., chlorine). The following analysis is not stoichiometrically-based, but rather is empirical in nature based upon measured formation rates and other data available to the expert panel.

3. The formation of DBPs is dependent upon many other water quality parameters beyond TOC and bromide, alone. Some of these include temperature and pH. The expert panel focused on TOC and bromide because it was assumed that management alternatives for the Delta had the opportunity to affect these variables, and therefore their control will influence subsequent DBP formation through treatment processes.

In the following presentation, bromide concentrations are provided in μg/L. It is recognized that bromide is often related to chloride concentration, as both are present in salt water which can intrude into the Delta system. If chloride concentrations relevant to stated bromide concentrations are of interest, the following conversion (Krasner et.al. 1994) can be used:

$$Cl^- \text{ (mg/L)} = \frac{Br^- (\mu g/L) + 4.96}{3.27}$$

4.2 DISINFECTION BY-PRODUCT FORMATION

4.2.1 Halogenated Organic By-Products

To assist in assessing the formation of DBPs from treated water from the Delta, a TTHM formation model developed for the Metropolitan Water District of Southern California was used (Malcolm Pirnie Inc., 1993). The model was developed from 648 data observations under bench-scale conditions using various blends of water diverted from the Delta. A chlorine-to-TOC dose ratio of 1:1 and free chlorine contact times of 60 and 120 minutes (to yield 1 and 2 log *Giardia* inactivation, respectively) were used in the analysis. A pH of 7.0, a temperature of 20° C and bromide concentration values of 50, 100, 150, 200 and 300 μg/L were also used. These conditions were within the experimental boundaries of the model. A more detailed description of the model is provided in Appendix A. The predicted TTHM values are summarized in Table 4.1.

The TTHM values were compared to the data supplied by the CUWA members, those in the open literature, and with the experience of the expert panel. A summary of the data provided by the CUWA members is included in Appendix B. The available data and the expert panel's experience agreed well with values in Table 4.1.

HAAs are also formed under these reaction conditions. The Stage 1 and Stage 2 proposed TTHM MCLs of 80 and 40 μg/L, and HAA5 MCLs of 60 and 30 μg/L, respectively, yield a mass concentration TTHM-to-HAA5 ratio of 1:0.75. The DBP data supplied to the expert panel by the CUWA members indicate that the TTHM values exceed the HAA5 concentrations by greater than this ratio of 1:0.75 in 84% of the 160 cases where paired TTHM and HAA5 data were available. Other data from both research and full-scale applications in waters containing at least 50 μg/L of bromide confirm these findings (Summers, et. al., 1996, Cheng, et. al., 1995, Shukairy, et.al., 1994). Thus, it was concluded that TTHMs are the DBP of regulatory concern for this evaluation of organic DBP precursor removal. It is important to note, however, that HAA5 represents only five of the nine HAA compounds and three of the four remaining are mixed bromo-chloro compounds which have been shown to have significant levels of formation in bromide containing waters (Cowman and Singer, 1996). If HAA6 or even HAA9 were to become regulated, then the controlling parameters and values could be affected. Further, for source water bromide levels

TABLE 4.1

PROJECTED TTHM FORMATION FROM TREATED WATER

		TTHM Formation (μg/L)	
Treated TOC (mg/L)	**Bromide (μg/L)**	**1 hr. contact**	**2 hr. contact**
2.0	50	23	28
	100	26	31
	150	28	33
	200	31	36
	300	36	43
2.25	50	26	31
	100	29	34
	150	31	38
	200	34	41
	300	40	48
3.0	50	34	41
	100	38	45
	150	41	49
	200	45	54
	300	53	63
3.25	50	37	44
	100	40	48
	150	44	53
	200	48	57
	300	57	68
3.9	50	43	52
	100	47	57
	150	52	62
	200	56	67
	300	66	79
4.55	50	49	59
	100	54	65
	150	59	71
	200	64	77
	300	76	90
5.2	50	55	66
	100	61	72
	150	66	79
	200	72	86
	300	85	101
5.4	50	57	68
	100	62	75
	150	68	82
	200	75	89
	300	87	104
6.0	50	62	74
	100	68	81
	150	75	89
	200	81	97
	300	95	114

considerably lower than 50 μg/L, it is recognized that HAA5 may control over TTHM (Cowman and Singer, 1996). These low bromide values were not considered relevant for this study.

A 20 percent safety factor on THM and HAA5 production was used in determining the source water conditions which would result in the target DBP concentrations following treatment. Thus a target TTHM concentration value of 64 μg/L (80% of 80 μg/L) was used for Stage 1 evaluations and 32 μg/L (80% of 40 μg/L) was used for Stage 2 evaluations.

4.2.2 Bromate Formation and Removal

Bromate Formation

The formation of bromate by ozone has come into focus only recently. The ultimate MCL for this compound is of critical importance to facilities which have bromide in their source water and are currently using, or anticipating the use of, ozone for drinking water treatment. Even small concentrations of bromide (< 50 μg/L) can result in measurable concentrations of bromate after ozonation. Therefore, the expert panel carefully evaluated available data from the CUWA members, other available literature, and ongoing research on bromate formation to evaluate potential source water constraints. Based upon these data, the expert panel arrived at initial conclusions regarding potential source water bromide concentrations which would be required to limit bromate formation within the potential regulatory scenarios in Chapter 2.

Unfortunately, bromate formation is strongly dependent upon the nature of the experimental system design (e.g., bench versus pilot or full-scale). In addition, bromate formation depends upon ozone dosage and residual, which is often specific for full-scale facilities, making the direct comparison of these data difficult. Therefore, a bromate model (Ozekin, 1994) was utilized to systematically evaluate the impact of ozone dose, bromide, TOC and pH on the formation of bromate and thereby supplement the available literature (Shukairy et.al., 1994), data supplied by the Alameda County Water District, Contra Costa Water District, Santa Clara Valley Water District, and Metropolitan Water District of Southern California, and the expert panel's experience. The model was developed from data from several source waters including water diverted from the Delta, including results from source waters containing bromide concentrations between 70 μg/L and 440 μg/L. A contact

time of 12 minutes was chosen and the concentrations of TOC, bromide, ozone dose and pH were varied over representative ranges as discussed in Chapter 3. At each pH, three ozone: TOC ratios were estimated to provide the following levels of inactivation; 1 log *Giardia,* 2 log *Giardia* and 1 log *Cryptosporidium.* The dose of ozone estimated for these inactivations decreases with decreasing pH as a higher ozone residual is maintained at the lower pHs. The results of the modeling supported the initial conclusions reached by the Panel based upon the available literature and review of the CUWA data. A more detailed description of the model is provided in Appendix A.

Figure 4.1 illustrates bromate formation as a function of source water bromide and ozonation pH. Relationships are shown for 1 and 2 log *Giardia* inactivation for both 5 and 10 μg/L bromate standards, and 1 log *Cryptosporidium* inactivation for a 5 μg/L bromate requirement.

Bromate Removal

Bromate removal after ozonation has been studied for the following technologies:

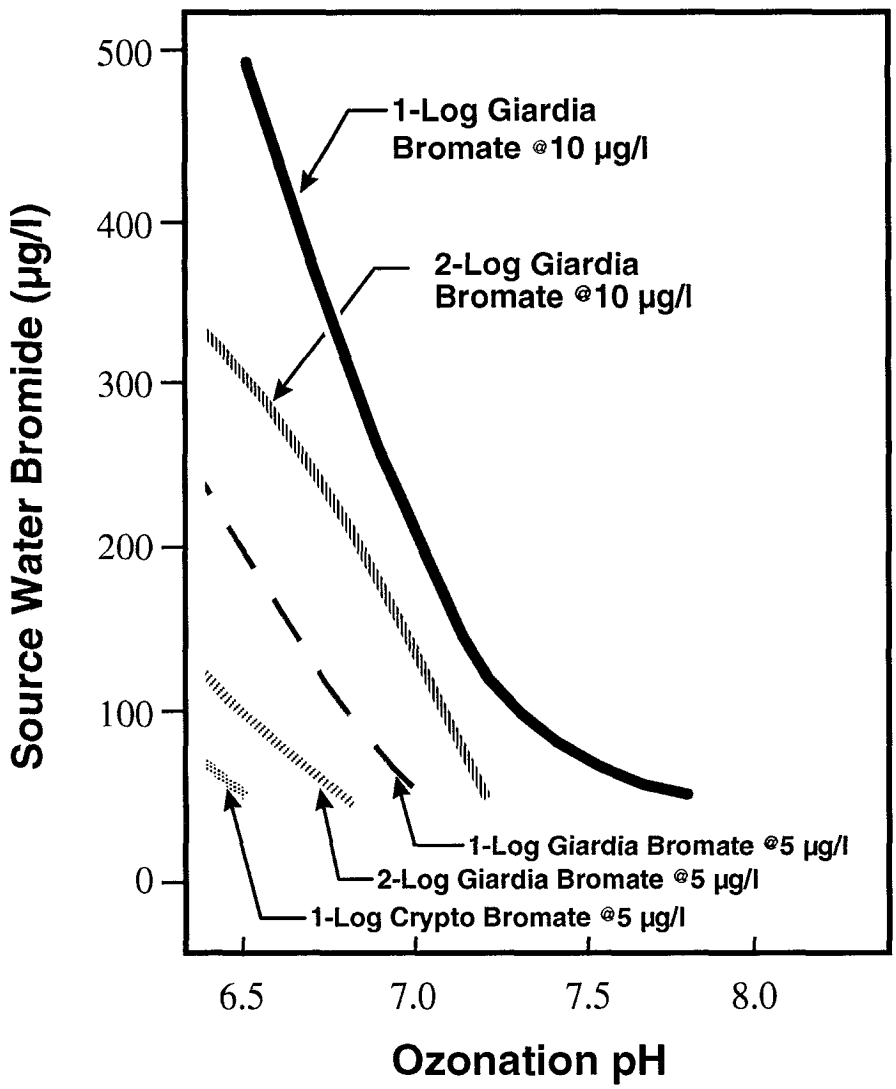
- Ferrous salt coagulation
- Reduction on a GAC surface
- UV Irradiation

It is important to recognize that research on bromate removal mechanisms is relatively new and has only been conducted for about the last five years. Consequently, the technologies presented below have been evaluated on a laboratory scale and published literature on full-scale applications is not available. It is premature to consider that these bromate removal technologies could be implemented reliably and cost-effectively on a full-scale basis.

Ferrous Salt Coagulation

Based on results of an AWWARF project conducted at the University of Colorado and currently in press, ferrous salts have been evaluated as a bromate removal technique with pre-ozonation. Up to 50 to 70 percent removal was reported though filterability problems (turbidity and particle breakthrough) were experienced. Ferric addition in conjunction with ferrous salts somewhat circumvented these filterability problems, though the issue has not yet been sufficiently evaluated. Bromate levels after ozonation ranging

Figure 4.1
Projected Bromide & Ozonation pH Requirements to Meet Potential Regulatory Scenarios for Microbial Inactivation and Bromate



Notes
1. Partially based on modeling equations of ozonation *(Ozekin, 1994).*
2. Approximate value only.

I:\30154\001\graphics\fig4-1.ppt

from 20 to 50 μg/L were reduced to below 10 μg/L. Consequently, it is not certain whether a 5 μg/L limit could be met (this depends, in part, on levels exiting the ozone contactor).

Reduction on a GAC Surface

Bromate removal in a GAC contactor is expected to be a two step process in which the bromate is first adsorbed onto the GAC and subsequently is reduced to bromide. Almost complete bromate removal can be expected on a fresh GAC bed. The adsorption and chemical reduction, however, rapidly reaches a steady state with a reduction in removal percentage of bromate from the influent water. The time to reach a steady state varies as a function of empty bed contact time (EBCT). In general, the rapid breakthrough shown to date would result in very short reactivation frequencies that would be difficult to implement on full-scale.

Expected bromate removals are based upon rapid small-scale column test (RSSCT) experiments without biological activity. The effect of biological activity on bromate removal is not known. Additional research is being currently conducted to study these effects.

UV Irradiation

UV irradiation from medium pressure mercury lamps has been found to be effective in the removal of bromate. Limited bench top continuous flow experiments have been performed thus far (Siddiqui and Amy, 1994). A contact time of less than 10 minutes combined with at a UV dose of 600 mW-sec/cm^2 was found to reduce 50 to 100 μg/L of bromate to less than 2 μg/L. Although this technology has been effective on a bench scale, the cost-effectiveness and reliability of UV in large scale application has not been demonstrated or completely evaluated. This technology has not been applied for any purposes at drinking water facilities the size of those operated by the CUWA members.

4.3 SOURCE WATER QUALITY FOR REGULATORY SCENARIOS

In the following discussion, source water quality in terms of TOC and bromide is estimated based upon the implementation of specific treatment technology (defined in Chapter 3) and the potential regulatory outcome (described in Chapter 2). Source water concentrations of TOC were evaluated between 2 and 7 mg/L. The 7 mg/L value represents the 90th percentile for TOC concentrations diverted from the Delta. Bromide concentrations

were evaluated up to 300 μg/L, as this was also considered a practical maximum in this evaluation. The data presented here are summarized in Section 4.5 both in tabular and graphical form.

4.3.1 Stage 1 D/DBP Rule and IESWTR

Enhanced Coagulation

For enhanced coagulation, source water TOC concentrations in the range of 3 to 7 mg/L and bromide concentrations of 50, 100, 150, 200 and 300 μg/L were evaluated. As discussed in Chapter 3, an alum dose of 40 mg/L at a coagulation pH of 7.0, and possibly as low as 6.5, was projected to be required to meet the TOC removal requirements. These TOC removal requirements, which are a function of influent alkalinity and TOC concentrations, and the resulting effluent TOC concentrations are shown in Table 4.2.

TABLE 4.2

DETERMINATION OF TREATED WATER TOC FOR ENHANCED COAGULATION

Influent TOC (mg/L)	Required Removal (%)	Treated TOC (mg/L)
3	25	2.25
4	25	3.0
5	35	3.25
6	35	3.9
7	35	4.55

To assess the TTHMs formed from the chlorination of effluents with this TOC range, the results in Table 4.1 can be utilized to draw the following projections:

1. For a 1 log *Giardia* inactivation using free chlorine for 60 minutes following enhanced coagulation, it was projected that the following water quality conditions would permit compliance with the stage 1 TTHM target of 64 μg/L in the regulatory scenario:

Raw Water TOC Concentration, mg/L	Bromide Concentration, μg/L
<7	<150-200
<6	<200
<5	<300

2. For a 2 log *Giardia* inactivation using free chlorine for 120 minutes following enhanced coagulation, it was projected that the following water quality conditions would permit compliance with the stage 1 TTHM target of 64 μg/L in the regulatory scenario:

Raw Water TOC Concentration, mg/L	Bromide Concentration, μg/L
<7	<50-100
<6	<150
<5	<200
<4	<300

For both of the above scenarios, certain combinations of raw water TOC and bromide concentrations that lie between the bounded concentration ranges are also projected to meet the target DBP values. For example, raw TOC concentrations between 6 and 5 mg/L and bromide concentrations between 200 and 300 μg/L, are projected to meet the DBP target values under a 1 log *Giardia* inactivation.

Ozone Disinfection

Bromate formation is the limiting DBP (as opposed to TTHM and HAA5) for the ozone treatment and disinfection strategy specified in this evaluation. It is the opinion of the expert panel that the controlling source water quality parameter for the formation of bromate, in the context of this evaluation, is bromide. It is recognized that higher concentrations of TOC will result in higher ozone dosages to achieve a given CT, and, as a result, may increase the concentration of bromate formed depending upon ozone residual, bromide concentration and potentially other parameters such as contactor design. Higher ozone dosages as a result of higher TOC also result in increased capital and operational costs for ozone treatment. Further, TOC can also be limiting to the extent that the biodegradable material, formed by the reaction between ozone and naturally-occurring organic matter (NOM), is not completely controlled through biofiltration, thereby creating an undesirable regrowth potential in the distribution system. The extent to which regrowth will be a problem is a function of the distribution system design, as well as disinfectant residuals maintained and other water quality parameters which are agency-specific. Nevertheless, sufficient data were not available to isolate the impact of TOC on bromate formation, in the absence of variation in bromide, pH and other water quality factors.

Based upon the data supplied by the CUWA members and other bromate formation studies and the model results, the expert panel concluded:

1. A bromate standard of 10 μg/L is restrictive at ambient pH values. At pH 7.8 (ambient for some pre-ozonated waters) it is projected that a bromide level of 50 μg/L or less would be needed to meet a bromate standard of 10 μg/L for 1 log *Giardia* inactivation. This bromate standard could not be met for ozone dosages providing 2 log *Giardia* inactivation at ambient pH.

2. Lowering the pH of ozonation is an effective means of reducing bromate formation. If the ozonation pH were lowered to 6.5, then a 10 μg/L level of bromate may be achievable with:

   - 1 log *Giardia* inactivation in the bromide range of less than 500 μg/L.
   - 2 log *Giardia* inactivation in the bromide range of less than 300 μg/L.

3. The potential for reliably meeting bromate standards using the bromate removal technologies currently being evaluated is unknown at this time. Although some technologies show promise, many have been demonstrated only on bench scale and the understanding of full-scale feasibility is limited. Consequently, the expert panel does not propose the use of bromate removal techniques as a well-understood and currently feasible and reliable method for increasing the allowable source water concentrations for bromide.

4. Limiting TOC concentrations were not estimated because of the limited availability and robustness of the data illustrating the impact of TOC on bromate formation, in the presence of bromide. It should be recognized, however, that higher TOC concentrations translate to higher ozone dosages to meet a given disinfection criterion and thereby can result in higher bromate formation. This is empirically validated in reviewing bromate formed during settled water ozonation as opposed to raw water ozonation. In general, when TOC concentrations are lower at a given facility, ozone dosages to achieve a given disinfection requirement are lower, and measured bromate concentrations are lower. Lower pH in settled water also helps reduce bromate concentrations.

The expert panel recognizes that there are variations in bromate production data and therefore looked for indications relating to threshold behavior. That is, evaluating source water bromide concentrations which result in a clear increase in bromate concentrations for a given set of ozonation conditions. Given some variation in the formation of bromate reported at lower source water bromide concentrations (< 50 μg/L), the expert panel took a position of plausible conservatism.

GAC and Membrane Treatment

It was the opinion of the expert panel that, given the relative flexibility that enhanced coagulation and ozone disinfection provided to meet the near-term regulatory scenario, CUWA members would not implement GAC or membrane treatment for this potential regulatory outcome. Consequently, source water quality limitations were not developed for these technologies in the near-term regulatory scenario.

4.3.2 Stage 2 D/DBP Rule and LT2SEWTR

Enhanced Coagulation

Using the same approach taken for the stage 1 D/DBP Rule and IESWTR, the following projections can be made for source water quality when using enhanced coagulation to achieve the potential long-term regulatory outcome:

1. For a 1 log *Giardia* inactivation using free chlorine for 60 minutes following enhanced coagulation, it was projected a raw water TOC concentration < 3.0 mg/L and a bromide concentration < 150 μg/L would permit compliance with the Stage 2 TTHM target of 32 μg/L in the regulatory scenario.

2. For a 2 log *Giardia* inactivation using free chlorine for 120 minutes following enhanced coagulation, it was projected that a raw water TOC concentration < 3.0 mg/L and a bromide concentration <50 μg/L would permit compliance with the TTHM target concentration of 32 μg/L in the regulatory scenario.

Ozone Disinfection

The estimates illustrated in Figure 4.1 were again used to evaluate potential source water limitations using ozone disinfection in the long-term regulatory scenario. The expert panel arrived at the following conclusions:

1. A bromate standard of 5 μg/L is very restrictive at pH values above 7. At pH 7.8 (ambient for some pre-ozonated waters) it is projected that this standard will not be met for any of the potential microbial inactivation requirements.

2. If the ozonation pH were lowered to 6.5, then a 5 μg/L level of bromate may be achievable with:

   - 1 log *Giardia* inactivation in the bromide range of less than 200 μg/L.
   - 2 log *Giardia* inactivation in the bromide range of 100 to 150 μg/L.

- 1 log *Cryptosporidium* inactivation with a bromide concentration of less than 50 μg/L.

3. The potential for reliably meeting bromate standard using the bromate removal technologies currently being evaluated is unknown at this time. Although some technologies show promise, many have been demonstrated only on bench scale and the understanding of full-scale feasibility is limited. Consequently, the expert panel did not propose the use of bromate removal techniques as a well-understood and currently feasible and reliable method for increasing the allowable source water concentrations for bromide.

4. Limiting TOC concentrations were not estimated because of the limited availability and robustness of the data illustrating the impact of TOC on bromate formation, in the presence of bromide. It should be recognized, however, that higher TOC concentrations translate to higher ozone dosages to meet a given disinfection criterion and thereby can result in higher bromate formation. This is empirically validated in reviewing bromate formed during settled water ozonation as opposed to raw water ozonation. In general, when TOC concentrations are lower at a given facility, ozone dosages to achieve a given disinfection requirement are lower, and measured bromate concentrations are lower. Lower pH in settled water also helps reduce bromate concentrations.

GAC Treatment

In assessing the use of GAC to meet the Stage 2 TTHM target of 32 μg/L, several constraints were used. The values in Table 4.1 suggest that the treated water TOC concentration must be below about 2.5 mg/L to approach this TTHM target within the range of bromide concentrations evaluated. To achieve this level of TOC in the finished water then the GAC influent TOC must be below 5.0 mg/L at a breakthrough (C/C_0) of 0.5, (see Table 3.2). As shown in Table 4.3, an EBCT of 20 minutes or greater is needed to achieve this effluent concentration while maintaining run times greater than 60 days (Summers et al., 1994, Hooper et al., 1996).

TABLE 4.3

ESTIMATED TIME TO 50 PERCENT BREAKTHROUGH AT DIFFERENT GAC EMPTY BED CONTACT TIMES

Influent TOC	Effluent TOC	Time to 50% Breakthrough (days)		
		EBCT (min) 15	EBCT (min) 20	EBCT (min) 30
3	1.5	62	83	124
4	2.0	47	68	93
5	2.5	38	50	75
6	3.0	32	42	63
7	3.5	27	36	54

The assumption of 10 to 15 percent TOC removal by the coagulation process prior to GAC yields a maximum raw water TOC of 5 mg/L for the GAC use scenario.

Using the results in Table 4.1 the following projections can be made based on the above analysis:

1. For a 1 log *Giardia* inactivation using free chlorine for 60 minutes following conventional coagulation and GAC, it was projected that a raw water TOC concentration of < 5 mg/L and a bromide concentration of < 150 μg/L would permit compliance with the Stage 2 TTHM target of 32 μg/L in the regulatory scenario.

2. For a 2 log *Giardia* inactivation using free chlorine for 120 minutes following coagulation and GAC, it was projected that a raw water TOC concentration of < 5 mg/L and a bromide concentration of <50 μg/L would permit compliance with the stage 2 TTHM target of 32 μg/L in the regulatory scenario.

Higher GAC influent TOC concentrations can be used with breakthroughs (C/C_0) lower than 0.5 to achieve effluent TOCs lower than 2.5 mg/L. For example an influent TOC of 6 mg/L and a C/C_0 of 0.4 yields a GAC effluent of 2.4 mg/L. The run times are below 60 days, however, even at an EBCT of 30 minutes. The run time at a C/C_0 of 0.4 is about 20 percent shorter than that at 0.5 (Summers and Hooper, 1997 unpublished data).

As discussed in Section 3.2.3, ozone can be used in combination with GAC to enhance disinfection and provide a good medium to remove biodegradable organic carbon (BDOC) formed by the application of ozone. Because of the particular constituents of concern in this evaluation, it was assumed that ozone and GAC operate somewhat

independently for microbial inactivation and removal of water quality contaminants. This particular treatment scenario allows GAC to be used when *Cryptosporidium* inactivation is required.

For GAC in combination with ozone, source water TOC can increase up to at least 7 mg/L (the 90th percentile for water diverted from the south Delta). Bromide concentrations using

ozone at a pH of 6.5 are limited to <200, 100 to <150, and <50 μg/L for 1 log *Giardia*, 2 log *Giardia*, and 1 log *Cryptosporidium* inactivations, respectively.

The source water for this combined treatment is limited by the ozonation process for bromide. For TOC values approaching 7 mg/L there is a concern that the TTHMs formed in the five minutes of contact with free chlorine will exceed the Stage 2 target. However, there are few TTHM formation data available at contact times as short as this. In addition there is concern that the GAC will be able to adequately control BDOC. High levels of ozonation by-products in the distribution system can lead to microbial regrowth, although currently these compounds are not regulated.

Membrane Treatment

As discussed in Chapter 3, two types of membrane treatment can be considered; membrane filtration and membrane softening. Because both of these processes represent "absolute barriers" to *Giardia* and *Cryptosporidium*, the source water quality does not vary based upon the extent of protozoan removal required. Based upon this understanding, the following projections were made:

1. For microfiltration, ozone, and chloramine treatment, it was assumed that ozone would be required to provide 3 log virus inactivation. This corresponds to CT values which are similar to 1.5 log *Giardia* inactivation. To provide the greatest degree of flexibility for source water bromide concentrations, it was assumed that ozonation would be conducted at pH 6.5. Referring to Figure 4.1, this results in a limiting source water bromide concentration of < 150 μg/L. A specific limit for source water TOC was not estimated for this treatment scheme. For TOC values approaching 7 mg/L (the 90th percentile for water diverted from the south Delta) there is a concern that biological filtration will be able to adequately control BDOC. High levels of ozonation by-products in the distribution system can lead to microbial regrowth, although currently these compounds are not regulated.

2. For ultrafiltration, ozone, and chloramine treatment, it was assumed that ozone would be required to provide 2 log virus inactivation. This corresponds to CT values which are similar to 0.5 log *Giardia* inactivation. To provide the greatest degree of flexibility for source water bromide concentrations, it was assumed that ozonation would be conducted at pH 6.5. This results in a limiting source water bromide concentration of < 300 μg/L. A specific limit for source water TOC was not estimated for this treatment scheme. For TOC values approaching 7 mg/L (the 90th percentile for water diverted from the south Delta) there is a concern that biological filtration will be able to adequately control BDOC. High levels of ozonation by-products in the distribution system can lead to microbial regrowth, although currently these compounds are not regulated.

3. For the application of nanofiltration followed by free chlorine addition for distribution system residual maintenance, TOC is limited by the extent to which TTHMs are formed in the distribution system. Under these conditions, the treated water TOC should be below 1 mg/L and the bromide level below 0.15 mg/L, as predicted by uniform formation conditions (Summers et. al., 1996). Assuming a 90 percent TOC removal and a 50 percent bromide removal by nanofiltration, a source water TOC of up to 10 mg/L is estimated at all source water bromide levels examined (< 300 μg/L).

4.4 IMPACT OF OTHER POTENTIAL REGULATORY OUTCOMES

4.4.1 Introduction

This section describes the impact of other potential regulatory outcomes on treatment requirements and/or allowable source water quality. It was not possible for the expert panel to evaluate all of the potential scenarios and the most plausible were discussed in Chapter 2. This section discusses broad trends based upon regulatory outcomes that were conceived during the regulatory negotiations, as affected by recent developments.

4.4.2 Lower MCLs and/or Maximum MCLs for Halogenated Organic Compounds

Plausibility: The current placeholder values could possibly go lower based on new health effects research. First, THM and HAA levels might be lowered. EPA has been conducting research on reproductive effects that may be associated with various THM and HAA species. Given the intense concern expressed during reg-neg over the New Jersey epidemiology studies and the potential associations with neural tube defects, lower MCLs

than the 40 μg/L and 30 μg/L would be plausible. In addition, a recently released study based in California developed an association between TTHM, individual THM compounds, and spontaneous abortion. Because this is considered an acute affect, this increases emphasis for considering a maximum value for DBPs, rather than a running annual average. Second, the current bromate MCL is based on what was considered to be the Practical Quantitation Level (PQL). Much effort is being focused on improving the method which could lead to a lower MCL, especially given the toxicology which suggests the high carcinogenic potency of bromate. Third, HAA regulatory levels are currently based on five species. There are, however, four other species that can form in the presence of bromide. Such compounds could dramatically increase the total HAA. Due to the apparently greater potency, it is possible that the MCL for total HAAs may decrease, though they may increase.

Impacts: Lower MCLs, or maximum rather than running annual average values, for THM or HAA will require either TOC or bromide to be reduced. A lower bromate PQL would require lower ozonation pH, depending on the actual level. But a very low level (e.g., less than 1 μg/L) could make use of ozone prohibitive.

4.4.3 MCLs For Individual DBP Species

Plausibility: A wide variation in relative potency of individual species within a given class has been observed. For example, bromodichloromethane is much more potent than chloroform, and has been associated with spontaneous abortion in a California based study. Its metabolism is more rapid leading to higher tissue concentrations, it has a greater capacity for binding proteins and lipids and the mutagenic response is much greater. These types of observations, particularly associated with bromine substitution in the place of chlorine-intensifying toxicity, lends credence to regulating individual species rather than broad chemical classes. Further, EPA recently proposed increasing the MCLG for chloroform from zero to 300 μg/L, thereby recognizing threshold behavior for carcinogens. These differences provide emphasis to regulating individual DBPs.

Implications: Low MCLs for species such as bromodichloromethane could preclude the use of chlorine for primary disinfection in waters containing measurable amounts of bromide. Membrane filtration, which requires some inactivation of virus, would require an

alternative disinfectant to chlorine (e.g., ozone). Enhanced coagulation would be of marginal benefit. GAC would still be relevant though it would need to be evaluated in light of the proposed levels.

4.4.4 DBPs Other Than THMs and HAAs Are Regulated

Plausibility: While there are a variety of DBPs, resources for health effects research are currently directed on the brominated analogues of the haloacids and trihalomethanes, not new compounds. Regulations for DBPs such as chloral hydrate, chloropicrin, haloketones or halocetonitriles are not anticipated.

Implications: It is not possible to evaluate the impacts of what appear to be less plausible regulatory outcomes, based upon the likelihood of health effects data supporting such regulation. In general, the more DBPs that are regulated, the greater the constraints on treatment technology and source water quality.

4.4.5 Regulating for a Minimum Total Risk; the "Risk Bubble"

Plausibility: Each technology results in a different mixture of DBPs in terms of relative concentrations. An individual MCL approach does not recognize this and does not allow for DBP - DBP tradeoffs. For example, chlorine will produce greater concentration of chlorinated, brominated and mixed bromo-chloro organics than ozone. Ozone, however, will produce more bromate and oxygenated compounds (e.g., aldehydes, ketones, carboxylic acids). In order to determine the lowest risk associated with the treatment options, it has been argued that a more comprehensive approach is needed, one that considers the wide array of by-products produced, not simply focused on THMs or HAAs. To this end, various approaches have been proposed and have recently been re-discussed in the stakeholder meetings. It has also emerged as part of the comparative risk framework currently being considered by EPA.

Implications: A mixtures approach may allow for greater flexibility in technology choice.

4.4.6 Implication of a Reproductive Endpoint

Plausibility: As there are some indications that reproductive health effects are associated with certain DBPs and that the exposures of interest (e.g., spontaneous abortion) are short-term rather than long-term (i.e., cancer). The current practice of running annual averages of quarterly samples for calculating compliance may not be appropriate. More frequent monitoring and enforcing of maximum levels could be required. Individual MCLs may also be prompted.

Implication: Going from running averages to maximum acute levels may decrease the range and variability of source water quality permissible. This would provide greater restrictions on the ability of all unit processes to meet water quality requirements and would lower the allowable TOC and bromide concentrations, and the allowable variability, depending upon the maximum values established.

4.4.7 Summary of Alternative Regulatory Scenarios

As with the wide array of issues being addressed as part of the overall Delta process, there is no single 'best' solution in formulation of future drinking water regulations -- there are a variety of trade-offs which need to be considered. It will be important that CUWA continue to keep these issues before the negotiated rulemaking committee.

4.5 SUMMARY

4.5.1 Summary of Source Water Quality Constraints

Table 4.4 summarizes projected source water quality requirements for TOC and bromide, depending upon the technology applied. In reviewing the values presented in this table, it is evident that there are various water quality constraints for TOC and bromide depending upon the technology used, the DBP concentrations allowed, and the level of microbiological inactivation required. As stated previously, which technology is implemented is agency-specific, and is dependent upon a host of constraints related to cost, permitting issues and residual disposal.

TABLE 4.4

SUMMARY OF SOURCE WATER QUALITY CONSTRAINTS [1]

TREATMENT SCENARIO/ DISINFECTION STRATEGY		MICROBIAL INACTIVATION REQUIRED					
		1 Log *Giardia* Inactivation		2 Log *Giardia* Inactivation		1 Log *Cryptosporidium* Inactivation [2]	
		TOC (mg/L)	Bromide (μg/L)	TOC (mg/L)	Bromide (μg/L)	TOC (mg/L)	Bromide (μg/L)
Potential Near-Term Regulatory Scenario							
Enhanced coagulation with free chlorine/chloramines		<7	<150-200	<7	<50-100		
		<6	<200	<6	<150		
		<5	<300	<5	<200		
				<4	<300		
Ozonation with Chloramines	at pH 7.8	N/E[3]	<50	N/E[3]	N/A[4]		
	at pH 6.5	N/E[3]	<500	N/E[3]	<300		
Potential Long-Term Regulatory Scenario							
Enhanced coagulation with free chlorine/chloramines		<3.0	<150	<3.0	<50	N/A[5]	N/A[5]
Ozonation with chloramines	at pH 7.8	N/E[3]	N/A[4]	N/E[3]	N/A[4]	N/E[3]	N/A[4]
	at pH 6.5	N/E[3]	<200	N/E[3]	<100 to 150	N/E[3]	<50
Granular Activated Carbon (GAC)		<5	<150	<5	<50	N/A[5]	N/A[5]
GAC With Ozone at pH 6.5		N/E [3]	<200	N/E[3]	<100-150	N/E[3]	<50
Membrane Treatment	MF with Ozone	N/E[3]	<150	N/E[3]	<150	N/E[3]	<150
	UF with Ozone	N/E[3]	<300	N/E[3]	<300	N/E[3]	<300
	Nanofiltration	<10 mg/L	<300	<10 mg/L	<300	<10 mg/L	<300

Notes:

1. Source water quality constraints are based upon achieving: 80 µg/L of TTHM, 60 µg/L of HAA5, and 10 µg/L of bromate for Stage 1 and 40 µg/L of TTHM, 30 µg/L of HAA5, and 5 µg/L of bromate for Stage 2, using the treatment and disinfection conditions presented in Chapter 3.
2. 1 log *Cryptosporidium* inactivation is not a part of the potential near-term regulatory scenario.
3. N/E = Not estimated. Limiting TOC concentrations were not estimated because of the availability and robustness of the data illustrating the impact of TOC on bromate formation, in the presence of bromide. It should be recognized, however, that higher TOC concentrations translate to higher ozone dosages to meet a given disinfection criterion and thereby can result in higher bromate formation. It is important to note that when ozone disinfection is used for treatment, the allowable TOC is not unlimited. There are concerns regarding the ability of biological filters or GAC to remove BDOC to adequate levels as TOC approaches 7 mg/L (the 90th percentile for water diverted from the Delta). In general, ozone disinfection is more effective and reliable as TOC decreases.
4. N/A = Not achievable. Bromide concentrations would have to be considerably less than 50 µg/L to achieve a bromate concentration of 5 or 10 µg/L. Data to determine the necessary bromide concentration relevant to this study were not available.
5. N/A = Not achievable. At this time, it is considered that free chlorine can not inactivate *Cryptosporidium* at dosages practical in water treatment.

4.5.2 Summary of Compliance Choices

Instead of presenting the data in a table which summarizes the allowable TOC and bromide concentrations as a function of different treatment processes for a given regulatory scenario, it is often helpful to graphically illustrate the technology that can be implemented, as a function of source water TOC and bromide, for a given regulatory scenario. That is, illustrate the area in which a given technology will allow compliance with a regulatory outcome, using a two-dimensional graphic illustrating bromide on the X-axis and TOC on the Y-axis. Therefore, the applicability of technologies in a given regulatory scenario as TOC or bromide increase can be visualized. A comparison of relationships for different regulatory scenarios illustrates how this "compliance forecast" changes when regulations change. It is important to note that the boundaries between technologies are not hard lines, but rather "transitional" regions. The absolute water quality boundaries which trigger the need for a different technology are extremely utility specific, and also are variable within a utility, itself, as criteria which effect technology selection other than water quality change.

Figure 4.2 illustrates the compliance forecast for the Stage 1 D/DBP Rule and IESWTR, for 1 and 2 log inactivations of *Giardia*. This figure illustrates that enhanced coagulation and ozone treatment can be used to meet the requirements up to TOC and bromide concentrations of 7 mg/L and 300 μg/L, respectively. In this figure, the colored area represents the region in which it is feasible to use the associated technology for combinations of TOC and bromide. For example, the yellow area describes the region in which ozone at pH 6.5 would be used for specific combinations of TOC and bromide, as opposed to enhanced coagulation. The gradual transition, and region of uncertainty, for combinations of TOC and bromide which require different technologies are also illustrated. The regulatory allowance to provide prechlorination with enhanced coagulation, which increases DBP production, has the impact of reducing the feasible region for enhanced coagulation. Which technology is selected in this transition zone is highly utility specific.

Figure 4.3 illustrates the compliance forecast for the potential Stage 2 D/DBP Rule and LT2ESWTR, for inactivations of 1 log *Giardia*, 2 log *Giardia*, and 1 log *Cryptosporidium*. In this figure, regions of technology application for enhanced coagulation, GAC, ozone and membranes (recall that the maximum bromide concentration for

Figure 4.2
Compliance Forecast for Stage 1 D/DBP Rule

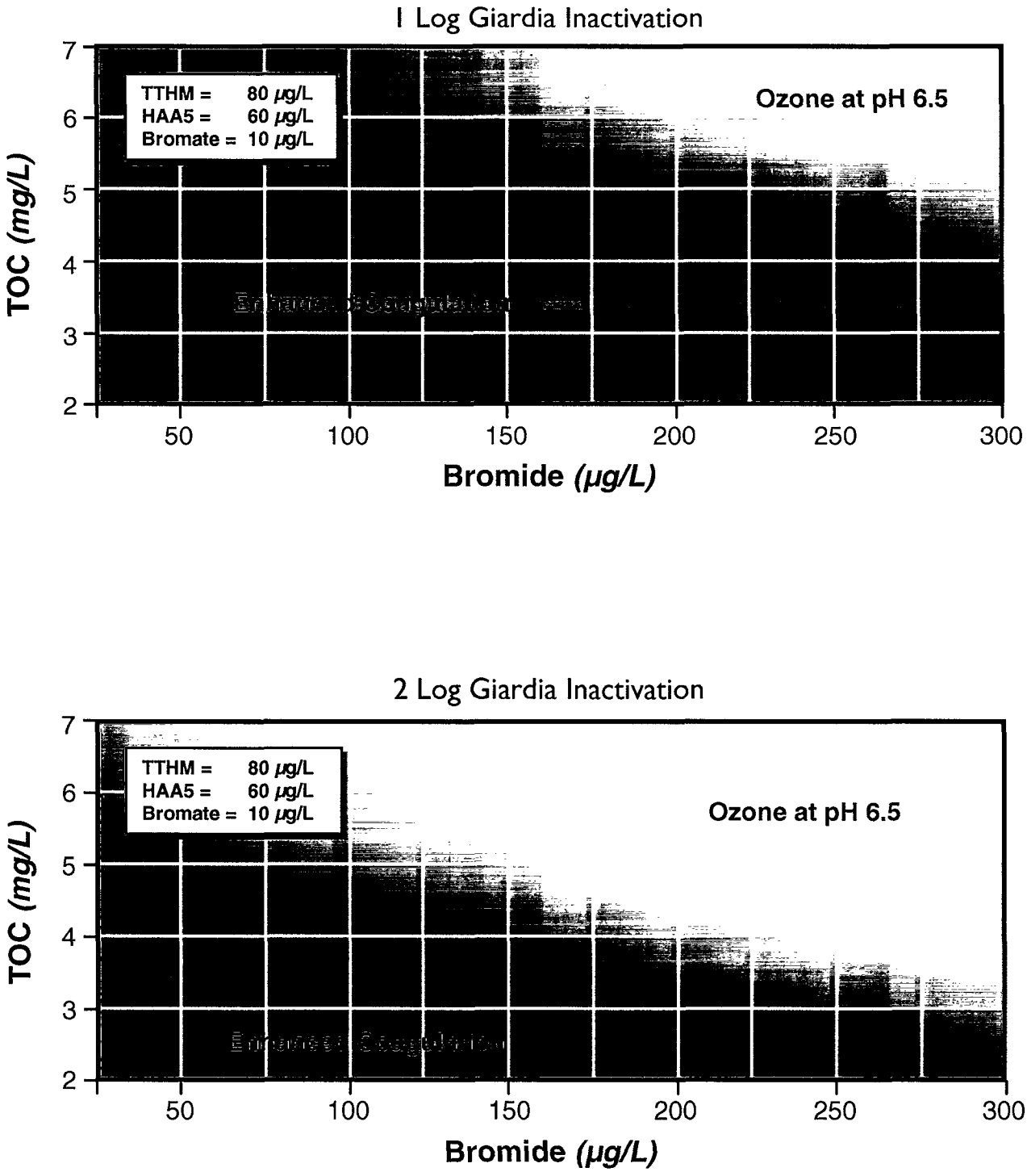


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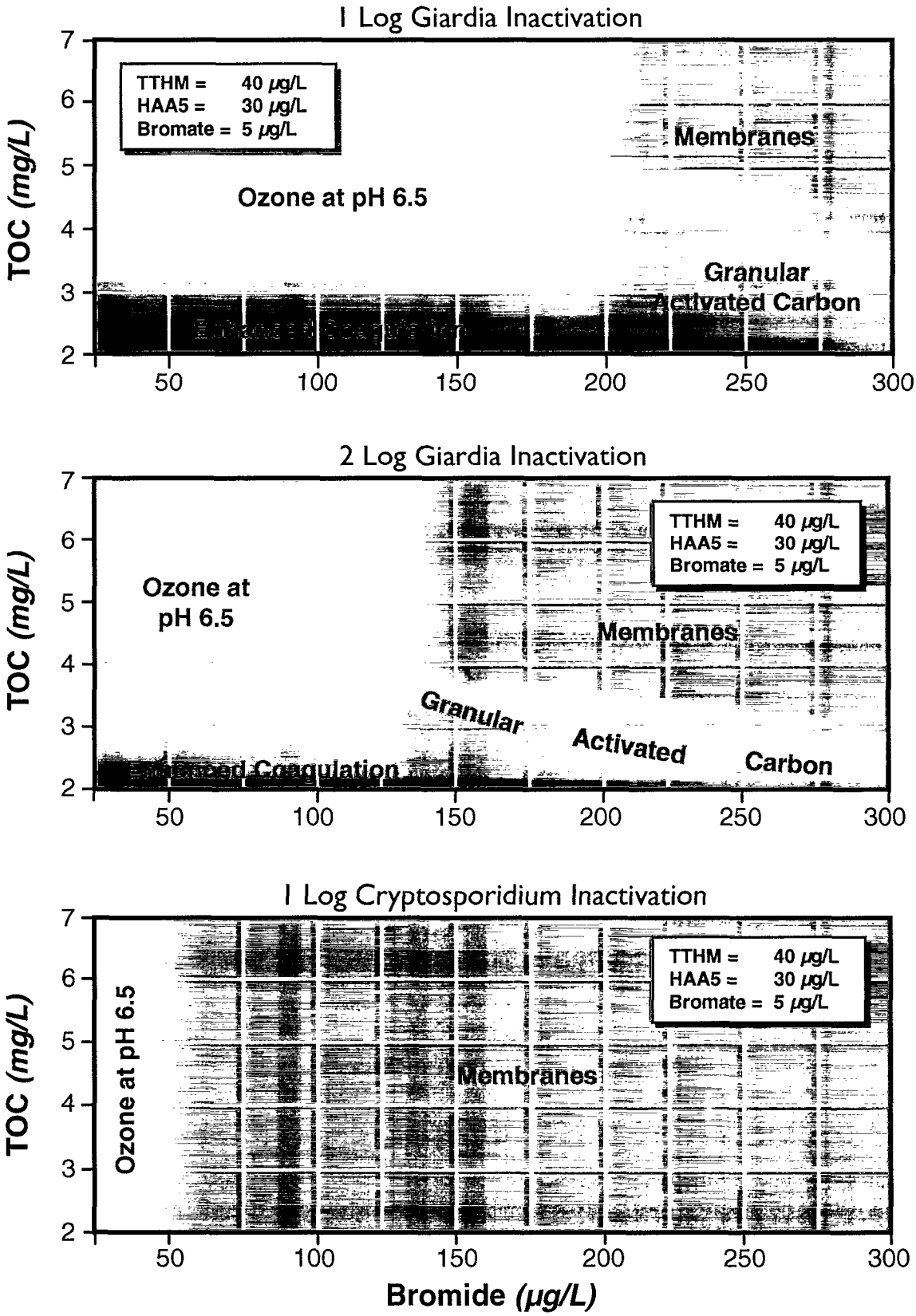
Figure 4.3
Compliance Forecast for Stage 2 D/DBP Rule



D-042222

microfiltration coupled with ozone is 150 μg/L) are illustrated. Individual systems may determine that other water quality benefits merit the use of more expensive technologies for certain water quality regions that are shown with less expensive technologies (e.g., ozone as opposed to enhanced coagulation; membranes as opposed to GAC). The figure was prepared to show "least cost" technology application, based upon the range of conceptual costs presented in Section 3.3. It is important to note that the region of feasibility for membranes in Figure 4.3 does not differentiate among MF/UF or NF/RO membranes. In general, only MF is somewhat limited for bromide when using ozone for virus inactivation. Table 4.4 summarizes these source water bromide limitations for MF.

It is evident that as the level of microbial inactivation increases, the technologies which may be used to meet the applicable regulation decreases. Of particular interest is that for a Stage 2 D/DBP Rule and LT2ESWTR which requires 1 log inactivation of *Cryptosporidium*, membrane technology plays a significant role in compliance choices.

As stated in Chapter 3, it is recognized that the above source water quality constraints are based upon the design criteria proposed, such as ozone:TOC dose ratios, ozone contact time, and single, multi-chamber contactor configuration. Other facility configurations, such as two-stage ozonation (e.g., ozone added at raw and settled water) and longer ozone contact times may yield different, and possibly more liberal, source water quality constraints. The source water quality constraints presented here are based upon typical ozone system designs throughout the country.

4.5.3 Concluding Remarks

The expert panel is aware of the significance of bromate in establishing limiting bromide levels in this evaluation. There are many factors that contribute to the uncertainty surrounding the projected numbers, including relatively few studies which have evaluated bromate formation in low bromide waters (< 50 μg/L), variations in treatment conditions which may reduce bromate formation (e.g., using both pre- and post-ozonation to reduce ozone dosages at any single location), and potentially lower CT values for ozone. It is the selected level of 5 μg/L in the long-term regulatory scenario, however, that most keenly influences the analysis. The rationale for this level (i.e., advances in detection limit, the weight of the carcinogenic evidence, the precedence for THM and HAA5 limits in Stage 2

at half the Stage 1 levels) in this analysis may be modified by a variety of factors including:

- A bromate versus brominated organic compound trade-off (i.e., addressing the difference between DBPs formed with ozone versus those formed with chlorine).
- Evidence of a cancer threshold for bromate (investigations underway).

On the other hand, there are other potential regulatory outcomes involving 1) further lowering the MCLs for DBPs, 2) the regulation of individual DBP species (rather than the groups of compounds represented by TTHM and HAA5 due to the potentially more severe health effects associated with brominated compounds), 3) regulating other DBPs beyond TTHMs and HAA5, including the addition of other HAAs (there are nine total) as analytical methods are developed and refined, 4) a comparative risk framework which balances all of the risk attributable to the DBPs formed, rather than providing specific MCLs for each group, and 5) concerns over reproductive and developmental effects that may be associated with DBPs, which may lower the regulatory levels and/or the permissible maximum concentration (i.e., annual averaging may no longer be the basis for determining compliance).

Given this understanding, if flexibility were provided to all agencies to implement either enhanced coagulation or ozone to meet the potential long-term regulatory scenario, then it is projected that a TOC of < 3.0 mg/L and a bromide of < 50 μg/L in water diverted from the Delta would be necessary. The TOC value is constrained by the formation of total trihalomethanes when using enhanced coagulation for TOC removal and free chlorine to inactivate *Giardia.* The bromide value is constrained by the formation of bromate when using ozone to inactivate *Cryptosporidium.* Looking only at the potential near-term regulatory scenario provides significantly more flexibility, with source water TOC concentrations ranging between 4 and 7 mg/L (the 90th percentile value in water diverted from the Delta) and bromide ranging between 50-100 and 300 μg/L, depending upon the extent of *Giardia* inactivation required (the near-term scenario does not include *Cryptosporidium* inactivation).

Similarly, the use of either GAC or membrane treatment in the long-term regulatory scenario broadens the allowable source water quality. For GAC, a source water TOC value

of 5 mg/L is acceptable with bromide ranging between 50 and 150 μg/L, depending upon *Giardia* inactivation.

If *Cryptosporidium* inactivation is required, however, ozone must be coupled with GAC. This allows the source water TOC concentration to increase to at least 7 mg/L (the 90th percentile value for waters diverted from the Delta), although bromide is constrained to < 50 μg/L even at an ozone pH of 6.5.

The use of microfiltration or ultrafiltration, coupled with ozone for primary disinfection and chloramines for secondary disinfection, is an "absolute barrier" for protozoan (*Giardia* and *Cryptosporidium*) removal. Viruses, however, must still be inactivated. This treatment scheme allows source water TOC concentrations to increase to at least 7 mg/L. The bromide concentration is again limited by bromate formation under ozone addition for virus inactivation, and is < 150 μg/L microfiltration and < 300 μg/L for ultrafiltration (less virus inactivation is required for ultrafiltration). If nanofiltration is used with free chlorination, source water quality can range up to 10 mg/L for TOC for all bromide concentrations evaluated (< 300 μg/L).

It is important to note that when ozone disinfection is used for treatment, the allowable TOC is not unlimited. There are concerns regarding the ability of biological filters or GAC to remove BDOC to adequate levels as TOC approaches 7 mg/L (the 90th percentile for water diverted from the Delta). In general, ozone disinfection is more effective and reliable as TOC decreases.

Finally, the feasibility of implementing either GAC or membranes in California, given cost considerations, environmental permitting constraints, and limited residual disposal options, is uncertain.

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APPENDICES

APPENDIX A
PREDICTIVE MODELS FOR DISINFECTION BY-PRODUCTS

A.1 THM PREDICTIVE EQUATIONS

Malcolm Pirnie, Inc. (1993) undertook a study on the formation of DBPs in chlorinated waters over a wide range of TOC and bromide concentrations for the Metropolitan Water District of Southern California. A 5 by 5 matrix of discrete samples containing incremental increases in TOC and bromide concentrations were prepared and evaluated. For this study, water was synthesized using low-TOC, low bromide Sacramento River water and high-TOC agricultural drainage water. High-bromide concentrations were achieved by adding sodium bromide.

The database used in this study, consisting of more than 900 observations, was constructed based upon the results of the source water quality monitoring program and the chlorination experiments from the 5 by 5 matrix. One portion of the database represented THM formation in jar-treated waters and another portion represented THM formation in 0.45 μm membrane filtered raw water.

Three sets of THM predictive equations were developed during this study using a non-linear power function format including total organic carbon (TOC), ultraviolet absorbance at 254 nm (UV-254), chlorine dose, bromide concentration, reaction time, temperature and pH as independent variables. The final TTHM predictive equation was based upon a portion of the database representing THM formation in 0.45 μm membrane filtered raw water (approximately 650 observations). Predictive capabilities of this equation were compared with THM formation in the jar-treated water (approximately 250 observations). The final TTHM equation developed was:

$$TTHM = 7.21\ TOC^{0.004}\ UV254^{0.534}\ (C1DOSE-7.6*NH_3\text{-}N)^{0.224}\ TIME^{0.255}\ (Br+1)^{2.01}\ (pH-2.6)^{0.719}\ TEMP^{0.480}$$

$$[r^2 = 0.96,\ F = 2010,\ p < 0.001]$$

This equation was developed at TOC concentrations ranging between 1.1 and 7.6 mg/L, bromide between 10 and 800 μg/L, contact times between 1 and 48 hours, and chlorine doses between 1.0 and 16.4 mg/L. The values for UV-254 to be input into the TTHM equation were predicted using a relationship between TOC and UV-254 developed in the study as follows:

$$\text{UV-254} = -0.0224 + (0.0374)(\text{TOC})$$
$$(r^2 = 0.92)$$

Using free chlorine as a disinfectant, a chlorine-to-TOC ratio of 1:1 and contact times of 1 and 2 hours were projected to yield 1 and 2 log *Giardia* inactivation, respectively. A temperature of 20 ° C and pH of 7 was also input to this equation to yield the values in Table 4.1 in the body of this report.

A.2 BROMATE PREDICTIVE EQUATION

The bromate model of Ozekin and Amy (Ozekin, 1994) was utilized to systematically evaluate the impact of ozone dose, bromide, DOC and pH on the formation of bromate. The model was developed from data from several source waters including waters diverted from the Delta. Source water bromide concentrations ranged between 70 and 440 μg/L with bromate concentrations ranging between 2 and 314 μg/L.

The model used has the following form:

$$BrO_3 = 1.63 \times 10^{-6}\ DOC^{-1.26}\ pH^{5.82}\ (O_3\ dose)^{1.57}\ Br^{0.73}\ time^{0.28}$$

A contact time of 12 minutes was chosen and the concentrations of DOC, bromide, ozone dose and pH were varied over a representative range as input to the above equation. Temperature was held constant at 20 ° C.

It is important to note that the model was only used to support conclusions reached by the expert panel prior to using the model. The bromate model was evaluated to investigate threshold behavior regarding formation at specific levels and to support the initial

conclusions reached by the expert panel. The results of the modeling should not be overemphasized. The results of the modeling supported the initial conclusions reached by the Panel based upon the available literature and review of the CUWA data.

APPENDIX B

CUWA MEMBER TREATMENT DATA

Data was provided by the CUWA members, including those resulting from the operation of their treatment facilities as well as bench and pilot studies. There are variations in these data which are unique to each treatment system. For example, some systems supplied data representing ozonation of only raw water, while others supplied data with both pre- and post-ozonation. The expert panel recognizes that there are unique aspects of process operation which can affect the ultimate formation of DBPs. For this study, however, the expert panel defined "unifying criteria" in Chapter 3 for enhanced coagulation and ozone which allow a comparison of these processes and a systematic method by which to evaluate the impact of water quality constraints on DBP formation. This appendix contains the data supplied by the CUWA members.

Utility ID:			ACWD					(ACWD, CCWD, EBMUD, MWD, SCVWD)											
1. Study ID:								(Optimization Study 9/95, etc.)											
2. Source water:								(River, lake, groundwater, etc.)											
3. Source water ID:								(State Project water, blend of...., etc.)											
5. Describe level of study:				Bench-scale				In this data sheet, "Filt." refers to data collected											
(Indicate with an 'X')				Pilot-scale				after coagulation, flocculation, sedimentation, and											
				Full-scale				filtration.											
6. Indicate with an 'X' if data reported as "Filt." are from samples collected after sedimentation only:																			
								or after sedimentation and filtration:											
WATER QUALITY DATA: CONVENTIONAL																			

Date	Time	TOC (mg/L)		UV-254 (1/cm)		Bromide (µg/L)		Turbidity (NTU)		Temperature (deg. C)		Disinfection By-products					
												TTHM (µg/L)		HAA5 (µg/L)		HAA6 (µg/L)	
		Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.
5/30/95		4.3	2.7					16.2		66.4							
6/6/95		4.3	2.0			40.0		29.0		65.9			28.9				
6/13/95		3.6	1.8			42.0		14.1		67.3			40.2				
6/20/95		3.5	1.9			60.0		15.6		66.3			44.0		48.0		
6/27/95		3.8	2.0			80.0		13.4		76.7			49.6				
7/4/95		4.2	2.3					17.4		73.3			45.2				
7/11/95		4.1	2.1			68.0		23.0		72.3			43.0				
7/18/95		3.8	1.9			50.0		19.5		73.5			45.9				
7/25/95			2.4			72.0		21.2		72.6			48.0				
8/1/95		4.1	2.2			65.0		13.3		78.3			48.0				
8/8/95		3.6	1.9			60.0		11.5		76.2			49.8				
8/15/95		3.1	2.0			60.0		11.4		77.0			58.9				
8/22/95		3.2	2.2			55.0		10.6		75.6			58.9				
8/29/95						50.0		11.5		71.2							
9/5/95		3.4	2.0			81.0	<20	12.5		70.5			61.1		37.0		44.0
9/12/95		4.1	3.3			42.0	12.0	2.3		68.9			86.9				
9/19/95		4.0	3.2			50.0	<20	2.2		68.4			85.9		58.0		65.0
9/26/95		4.0	2.8			53.0	10.0	8.3		67.9							
10/3/95		4.1	2.8			49.0	17.0	5.0		64.1			55.4		43.0		49.0
10/10/95		4.3	3.0			44.0	<40	4.4		62.6			72.0				
10/17/95		4.2				43.0		6.6		63.0							
10/24/95		3.9	2.8			47.0	14.0	4.3		61.9							
10/31/95		3.8	2.5			45.0	12.0	6.5		61.7			58.6		35.0		40.0
11/7/95		3.8	2.6	0.19	0.07	47.0	13.0	5.3		59.9			72.1				
11/14/95		4.3	3.1	0.18		39.0	12.0								46.0		52.0
11/21/95		3.4	3.3	0.19	0.10	42.0	16.0										
11/28/95				0.14	0.10	86.0	16.0						55.5		23.0		28.0
12/5/95		4.4	3.4	0.13	0.09			1.6		58.5			73.1				
12/12/95		4.6	4.0	0.12	0.08	39.0	<20	2.2		58.0					56.0		62.0
12/19/95		4.7	3.7	0.14	0.10	38.0	<20	3.9		55.8			73.3				
12/26/95		3.1	2.0	0.12	0.09	97.0	24.0	7.6		52.5					31.0		38.0
1/2/96		3.3	2.1	0.13	0.09	150	36.0	3.6		53.8			64.6				
1/9/96		6.4	3.7	0.24	0.10	110	31.0	4.8		52.7			75.2		54.0		63.0
1/16/96		6.4	3.5	0.27	0.11	87	24.0	4.0		51.4			80.0				
1/23/96		3.0	2.4	0.18	0.16			9.3		50.7							
1/30/96		3.5	3.2	0.20	0.10			20.0		51.4			77.8				
2/6/96		5.6	3.6	0.20	0.11								75.0				
2/13/96		5.6	3.6	0.17	0.08								76.1				
2/20/96		5.8	3.6	0.13	0.31								88.0				
2/27/96		5.8	3.0	0.20	0.11								72.8				
3/5/96		0.0	3.1	0.22	0.09		14.0						80.7		54.0		57.0
3/12/96		5.6	3.1	0.21	0.10		<20										
3/19/96		5.5	3.4	0.22	0.10		<20						61.3		49.0		52.0
3/26/96		5.3	3.1	0.21	0.09		14.0						81.3				
4/2/96				0.20	0.09								57.2		31.0		38.0
4/9/96				0.21	0.08								94.7				
4/16/96		4.4	3.0	0.20	0.10		<10.0								59.0		68.0
4/23/96		4.2	2.8	0.21	0.09		29.0						71.4				
4/30/96			2.4		0.09		34.0						76.7		41.0		52.0
5/7/96		3.7	2.6	0.20	0.09		41.0						73.3				
5/14/96		3.6	2.8	0.21	0.09		45.0						85.0		43.0		55.0
5/21/96					0.09												
5/28/96		3.8	2.1	0.22			20.4						52.3		34.0		41.0
6/4/96		3.6	2.3	0.22	0.08		24.6						70.4				
6/11/96			1.9		0.08		17.2						80.1		38.0		43.0
6/18/96			1.8	0.19	0.08		10.6						53.9				
6/25/96			1.9		0.08		25.2						43.9				
7/2/96		3.2	2.0				20.4						64.8				
7/9/96							13.7										

Utility ID:	ACWD	(ACWD, CCWD, EBMUD, MWD, SCVWD)	
1. Study ID:	Routine Monitoring	(Optimization Study 9/95, etc.)	4. If blended source water indicate sources and proportions:
2. Source water:	River	(River, lake, groundwater, etc.)	Source / %
3. Source water ID:	South Bay Aqueduct	(State Project water, blend of...., etc.)	
5. Describe level of study: (indicate with an 'X')	Bench-scale Pilot-scale X Full-scale	In this data sheet, "Filt." refers to data collected after coagulation, flocculation, sedimentation, and filtration.	
6. Indicate with an 'X' if data reported as "Filt." are from samples collected after sedimentation only:			
or after sedimentation and filtration:			

WATER QUALITY DATA: PRE-OZONE

Date	Time	TOC (mg/L)			UV-254 (1/cm)			Alkalinity (mg/L as CaCO3)			Hardness (mg/L as CaCO3)						Bromide (µg/L)			Chloride (mg Cl-/L)			Turbidity (NTU)		
		Raw	Ozon.	Filt.	Raw	Ozon.	Filt.	Raw	Ozon.	Filt.	Total			Calcium			Raw	Ozon.	Filt.	Raw	Ozon.	Filt.	Raw	Ozon.	Filt.
											Raw	Ozon.	Filt.	Raw	Ozon.	Filt.									
1/3/95		5.8	5.4	3.4				82		84	132									108.0			8.77		0.05
1/10/95		5.6		2.9				74		80	104									70.0			30.00		0.06
1/17/95		5.9	5.7	3.3				139		138	162						100.0			41.0			68.80		0.04
1/24/95		5.9	5.9	3.5				140		162	168						80.0			33.0			50.70		0.05
1/31/95		6.0	6.4	3.5				170		158	154						70.0			25.0			56.00		0.04
2/7/95		5.8	5.6	3.3				152		92	160									26.0			36.50		0.04
2/14/95		5.7	5.4	3.4				158		160	140						71.0			61.0			29.70		0.05
2/21/95		5.8	5.3	3.5				152		166	142						72.0			40.0			24.30		0.05
2/28/95		5.6	5.4	3.7				158		160	144						56.0			42.0			10.80		0.03
3/7/95		5.8	5.4	3.7				122		120	136						83.0			61.0			8.20		0.05
3/14/95		6.1	5.6	3.1				110		126	144						50.0			34.0			17.10		0.05
3/21/95		5.8	5.1	3.2				102		98	120						90.0			45.0			21.20		0.06
3/28/95		6.1	5.3	3.2				128		130	136						40.0			41.0			61.50		0.06
4/4/95			5.4	3.3				94		94	110						170.0			90.0			9.00		0.06
4/11/95		5.9	5.7	3.7				96		112	120						200.0			75.0			17.00		0.04
4/18/95		5.6	5.3	3.2				106		112	126						110.0			41.0			16.80		0.04
4/25/95		5.8	5.7	3.4				90		94	140						120.0			82.0			12.17		0.06
5/2/95		5.3	5.1	3.2				112		106	126						87.0			144.0			10.78		0.03
5/9/95		5.1	5.0	2.8				78		88	108						90.0			47.0			8.68		0.04
5/16/95		4.7	4.3	2.4				70		72	88						60.0			34.0			11.23		0.05
5/23/95		5.0	4.7	2.2				64		72	80						40.0			35.0			23.00		0.04
5/30/95		4.3	3.8	1.9				56		58	82									30.0			15.95		0.06
6/6/95		4.6	4.4	1.8				44		44	62						40.0			24.0			28.67		0.04
6/13/95		3.9	3.4	1.6				44		44	50						42.0			25.0			13.17		0.03
6/20/95		3.7	3.3	1.8				38		46	56						60.0			60.0			14.93		0.06
6/27/95		3.9	3.7	1.8				48		52	66						80.0			58.0			14.10		0.08
7/4/95		4.0	2.7	1.9				42		50	56									40.0			16.47		0.02
7/11/95		3.7	3.2	1.6				44		46	60						68.0			26.0			20.62		0.04
7/18/95		3.6	2.4	1.5				40		44	47						50.0			25.0			17.78		0.04
7/25/95		4.0	3.1	1.8				45		53	56						72.0			19.0			19.32		0.05
8/1/95		4.6	2.6	1.6				49		51	54						65.0			18.0			14.20		0.06
8/8/95				1.5				50		52	48						60.0			26.0			12.73		0.07
8/15/95		3.2	1.3	1.5				48		50	52						60.0			25.0			12.13		0.05
8/22/95		3.1	1.8	1.5				54		59	60						55.0			47.0			10.67		0.06
8/29/95		3.1	2.6	1.4				55		61	54						50.0			23.0			10.62		0.05
9/5/95		3.7	3.6	1.5				59		66	60						81.0	<5	<20	25.0			12.37		0.06
9/12/95		4.4	2.2	2.3				106		132	127						42.0		<40	28.0			1.94		0.05
9/19/95		4.5	2.7	2.1				112		128	114						50.0		<20	31.0			1.68		0.06
9/26/95		4.2	4.2	2.3				96		106	100						53.0		<20	30.0			8.40		0.08
10/3/95		4.1	4.4	2.4				89		94	110						49.0		<40	52.0			4.91		0.07
10/10/95		4.5	3.7	2.6				103		108	104						44.0		<40	38.0			3.86		0.06
10/17/95		4.2	3.1	2.5				102		109	111						43.0		<20	129.0			6.65		0.06
10/24/95		3.9	3.7	2.3				94		104	102						47.0		12.0	18.0			3.77		0.07
10/31/95			2.9	2.1				90		94	96						45.0		<20	21.0			4.36		0.07
11/7/95			2.8	2.2			0.09	88		92	98						47.0		<20	20.0			4.70		0.07
11/14/95		4.2	2.6	2.5			0.07	114		120	130						39.0		10.0	5.0			3.15		0.06
11/21/95		4.4	3.2	2.8			0.07	106		124	124						42.0		<20	12.0			2.63		0.07
11/28/95							0.09	54		58	88						86.0		<20	37.0			8.61		0.06
12/12/95		4.6	4.3	3.3			0.07	156		168	172						39.0		<20	14.0			2.64		0.05
12/19/95		4.6	3.7	3.3			0.07	137		141	160						38.0		<20	13.0			4.22		0.06
12/26/95		3.3	3.3	1.7			0.06	84		90	90						97.0		<20	25.0			5.85		0.06
1/2/96		3.4	4.0	1.9			0.07	66		70	82						150.0		<20	50.0			4.83		0.07
1/9/96		6.4	4.6	2.9			0.07	79		82	104						110.0		47.0	44.0			5.37		0.07
1/16/96		6.2	4.0	2.8			0.13	72		90	140						87.0		<20	50.0			4.48		0.07
1/23/96		5.6	6.6	3.5			0.08	75		89	92									40.0			10.10		0.06
1/30/96		5.8	4.3	2.7			0.07	110		122	130									26.0			21.00		0.06
2/6/96		5.8	3.3	3.4			0.08	147		153	160									21.0			13.70		0.07
2/13/96		5.4	3.8	3.4			0.03	90		92	168									11.0			13.00		0.06
3/12/96		5.5	5.0	3.0			0.09	88		86	134						21.0		<20	10.0			33.20		0.08
3/19/96		5.4	5.2	2.8			0.10	96		100	142						17.0		<20	14.0			17.10		0.07
3/26/96		5.2	4.8	2.6			0.08	88		89	122						41.0		<20	13.0			14.00		0.07
4/2/96		3.3	3.2				0.09	54		59	74						94.0		<20	37.0			18.20		0.05
4/9/96		3.8	3.7	2.2			0.09	58		62	96									54.0			5.90		0.06
4/16/96		4.0	3.7	2.4			0.10	62		68	102						95.0		11.0	30.0			5.70		0.07
4/23/96		4.0	4.1	2.2			0.09	70		76	100						110.0		<10	54.0			7.00		0.06
4/30/96		3.7	3.9	1.9			0.09	50		54	98						120.0		<10.0	60.0			13.60		0.06
5/7/96		3.7	3.7	1.9			0.09	50		52	90						140.0		27.0	60.0			7.30		0.05
5/14/96		3.7	3.8	1.9			0.09	42		51	88						130.0		<20	61.0			7.10		0.06
5/21/96								52		55	102									48.0			5.90		0.07
5/28/96		3.8	3.0	1.7			0.09	68		64	106						79.0		<1	28.0			21.70		0.06
6/4/96		3.5	3.4	1.6			0.08	50		54	76						75.2		<1	16.0			15.80		0.07
6/11/96		3.4	3.3	1.5			0.09	54		68	58						56.0		<3	81.0			19.80		0.07
6/18/96		3.8	3.7	1.6			0.08	58		73	82						59.6		<3	32.0			39.00		0.07
6/25/96		3.2	3.0	1.6				63		74	102						52.7		13.8	13.0			19.70		0.08

D-042233

D-042233

Utility ID:																							
1. Study ID:																							
2. Source w																							
3. Source w																							
5. Describe																							
(indicate wi																							
6. Indicate																							
WATER QU																		TREATMENT CONDITIONS					

Date	pH			Temperature			Bromate			Disinfection By-products									Ozonation Conditions				
	()			(deg. C)			(µg/L)			TTHM (µg/L)			HAA5 (µg/L)			HAA6 (µg/L)			Ozone dose	Ozone residual	Contact time	Ozone pH	Ozone temp.
	Raw	Ozon.	Filt.	Raw	Ozon.	Filt.	Raw	Ozon.	Filt.	Raw	Ozon.	Filt.	Raw	Ozon.	Filt.	Raw	Ozon.	Filt.	(mg/L)	(mg/L)	(min)	()	(deg. C)
1/3/95	7.7		7.0	8.8								7.8			9			14	2.2	0.49		8.1	8.8
1/10/95	7.8		6.7	10.6								7.7						6	2.3	0.64		8.2	10.8
1/17/95	8.0		7.0	11.3								4.2			6			5	1.7	0.44		8.0	11.3
1/24/95	8.0		7.0	11.6								4.8						4	1.8	0.40		8.5	11.6
1/31/95	7.9		6.9	11.6								4.4						5	2.0	0.37		8.6	11.6
2/7/95	7.9		6.8	12.3								4.8						5	3.5	0.91		8.3	12.3
2/14/95	8.0		6.9	10.2								5.1			5			6	4.8	0.83		8.4	10.2
2/21/95	7.9		7.1	10.0								4.8						3	3.2	0.68		8.2	10.0
2/28/95	8.4		7.4	11.2								5.1			6			7	3.8	0.49		8.2	11.2
3/7/95	8.1		7.2	12.0														18	3.8	0.66		7.6	12.0
3/14/95	8.1		7.1	11.5								3.6			3			6	3.7	0.74		7.7	11.5
3/21/95	8.2		7.1	12.0					6.0			4.8						4	3.7	0.69		7.3	12.0
3/28/95	8.0		7.0	11.2								3.8			4			3	3.8	0.62		6.9	11.2
4/4/95	8.5		7.0	16.0					12.0			82.8						4	3.9	0.38		7.4	16.0
4/11/95	8.6		7.1	15.3								8.3			6			3	3.5	0.73		7.5	15.3
4/18/95	8.3		7.0	14.1					9.0			4.9						3	4.7	0.59		7.8	14.1
4/25/95	8.4		7.1	15.5					8.0			6.9						2	3.8	0.62		7.4	15.5
5/2/95	8.2		7.2	15.7								5.4							3.5	0.55		7.2	15.7
5/9/95	8.2		6.9	16.1								13.3							4.0	0.60		7.4	16.1
5/16/95	7.6		6.8	16.5								8.4							3.9	0.77		7.5	16.5
5/23/95	7.7		6.6	18.0								5.1							3.6	0.83		7.6	18.0
5/30/95	7.3		6.6	19.3								5.0							4.2	0.52		7.7	19.3
6/6/95	6.9		6.2	19.0								6.1							3.3	0.59		7.4	19.0
6/13/95	7.4		6.5	19.2								5.0							3.6	0.60		7.7	19.2
6/20/95	7.5		6.6	19.1					6.0			4.7			3				3.8	0.69		7.6	19.1
6/27/95	7.8		6.6	24.9					8.0			6.1							3.3	0.81		7.3	24.9
7/4/95	7.4		6.4	22.9					8.0			5.6							4.0	0.47		8.0	22.9
7/11/95	7.2		6.3	22.7								6.3			2				4.2	0.61		8.0	22.7
7/18/95	7.4		6.3	23.2					10.0			4.1							4.1	0.52		7.5	23.2
7/25/95	7.5		6.4	21.6					5.0			4.3			3				4.2	0.42		6.9	21.6
8/1/95	7.6		6.2	25.9					9.0			6.2							2.0	0.30		6.9	25.9
8/8/95	7.7		6.5	24.5					6.0			3.9			3				3.8	0.83		7.6	24.5
8/15/95	7.4		6.1	25.4					7.0			3.8							4.1	0.52		7.4	25.4
8/22/95	7.7		6.3	24.4					10.0						11				2.2	0.28		7.5	24.4
8/29/95	7.6		6.6	22.0					10.0													7.6	22.0
9/5/95	7.3		6.6	21.6			<5		11.0			3.3			10			14	2.2	0.94		7.7	21.6
9/12/95	8.0		6.9	19.4			6.0		15.0			32.8							4.1	1.20		7.6	19.4
9/19/95	8.0		7.0	21.1			21.0		14.0			13.8			4			6	6.5	0.65		8.1	21.1
9/26/95	7.5		6.8	19.9			<5		23.0										3.1	1.00		7.7	19.9
10/3/95	6.9		6.9	17.8			<5		5.0			6.1			4			5	2.7	0.82		7.8	17.8
10/10/95	6.9		6.9	16.8			<5		<5			5.8							2.6	0.76		7.7	16.8
10/17/95	7.6		6.9	17.1			9.0		<5										2.8	0.56		8.1	17.1
10/24/95	7.4		6.9	16.7			<5		<5										3.0	0.77		7.5	16.7
10/31/95	7.5		6.9	16.6			<5		<5			3.7			3			4	2.9	0.67		7.5	16.6
11/7/95	7.6		6.9	15.4			<5		<5			6.2							3.0	0.82		7.6	15.4
11/14/95	7.7		6.8	15.0			<5		<5						4			5	3.0	0.78		7.7	15.0
11/21/95	7.6		6.9	15.0			<5		<5										2.9	0.81		7.8	15.0
11/28/95	8.1		6.7	14.6			14.0		<5			3.0			4			5	3.5	0.66		7.8	14.6
12/12/95	7.7		7.0	14.5			<5								5			6	2.4	0.65		7.9	14.5
12/19/95	7.8		7.2	13.5			<5		<5			6.2							2.3	0.77		7.9	13.5
12/26/95	7.7		6.9	11.8			<5		<5						2			3	2.1	0.50		7.9	11.8
1/2/96	8.1		6.9	12.6			<5		6.0			4.6							2.1	0.48		7.7	12.6
1/9/96	7.5		6.6	11.2			<5		6.0			5.8			5			7	3.5	0.46		8.2	11.2
1/16/96	7.5		6.6	10.8			<5		<5			12.2							3.6	0.50		7.8	10.8
1/23/96	7.6		6.4	10.2					5.0										3.7	0.79		8.1	10.2
1/30/96	7.7		6.3	10.8								32.9							3.5	0.84		8.2	10.8
2/6/96	7.8		7.0	11.6								5.8							3.1	0.54		8.5	11.6
2/13/96	7.8		7.0	11.8								6.2							2.5	0.50		8.1	11.8
3/12/96	7.9		6.9	12.3			<5												4.1	0.86		8.3	12.3
3/19/96	7.9		7.0	12.7			<5		<5			6.7			5			6	3.0	0.68		7.5	12.7
3/26/96	7.9		6.8	13.2			<5		<5			5.4							4.1	0.81		7.6	13.2
4/2/96	7.7		6.4	15.3					<5			8.6			3			4	3.4	0.95		7.4	15.3
4/9/96	8.2		6.9	16.3					15.0			2.9							4.0	0.79		7.5	16.3
4/16/96	7.8		7.0	16.3			8.5								2			3	3.8	0.83		7.7	16.3
4/23/96	8.1		6.9	17.0			8.0		9.0			2.8							3.8	0.66			17.0
4/30/96	8.2		6.7	19.1			15.0		12.0			1.3			3			4	3.6	0.75			19.1
5/7/96	8.5		6.9	19.3			18.5		14.0			2.6							3.8	0.54			19.3
5/14/96	8.1		6.8	19.8			13.5		25.0			5.8			2			3	3.3	0.90			19.8
5/21/96	8.3		7.0	17.7					22.0										3.0	0.89			17.7
5/28/96	7.5		6.7	17.8			<4.5					3.1			2			3	2.7	0.51			17.8
6/4/96	7.6		6.4	24.0			12.57		<4.5			2.3							2.6	0.54			24.0
6/11/96	7.4		6.5	22.6			<4.5		<4.5			2.4			1			2	2.5	0.31			22.6
6/18/96	7.5		6.7	21.4			<4.5		<4.5			2.8							2.6	0.35			21.4
6/25/96	7.7		7.0	20.7			<4.5		<4.5			1.6							2.7	0.45			20.7

Utility ID:	ACWD	(ACWD, CCWD, EBMUD, MWD, SCVWD)
1. Study ID:	Enh. Coagulation (from EC study data)	(Optimization Study 9/95, etc.)
2. Source water:	River	(River, lake, groundwater, etc.)
3. Source water ID:	South Bay Aqueduct	(State Project water, blend of...., etc.)

5. Describe level of study: (indicate with an 'X')		Bench-scale
		Pilot-scale
	x	Full-scale

In this data sheet, "Filt." refers to data collected after coagulation, flocculation, sedimentation, and filtration.

6. Indicate with an 'X' if data reported as "Filt." are from samples collected after sedimentation only:	x
or after sedimentation and filtration:	x

WATER QUALITY DATA: CONVENTIONAL

Date	Time	TOC (mg/L)			Alkalinity (mg/L as CaCO3)		Hardness (mg/L as CaCO3)				Turbidity (NTU)		pH ()		Temperature (deg. C)	
							Total		Calcium							
		Raw	Filt.	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.
			(settled)	(filt)								(settled)				
		3.2	1.9		104		132				11.5	2.2	7.7		21.2	
		3.1	2.1		105		118				6.0167	1.1	8.1		20.3	
		3.7	2.8	2.4	112		120				4.65	1.7	7.6		17.3	
		4.0	2.7	2.8	127		150				2.1667	0.8	7.9		19.1	
		3.6	2.6	2.5	128		144				2.1167	2.3	7.9		19.9	
		5.8	4.0	3.4	152		142				24.333	6.9	7.9		10	
		5.6	4.2	3.7	158		144				11.933	4.4	8.4		11.1	
		5.8	4.1	3.7	127		134				8.2833	2.4	8.1		11.3	
		6.1	3.8	3.2	110		144				17.117	3.9	8.2		12.5	
		5.8	3.6	2.9	102		120				21.233	2.6	8.3		12.4	
		6.1	3.3		117		134				76.667	13.4	8		11.9	
		5.9	4.3	3.6	96		116				13.633	2.7	8.6		15	
		5.6	4.0	3.1	87		124				8.9667	2.6	8.7		14.6	
		5.8	4.2	3.5	98		118				11.55	3.4	8.5		15.5	
		5.3	3.7	3.4	105		126				10.783	3.3	8.3		15.7	
		5.1	3.7	2.8	78		108				8.6833	2.5	7.9		16.1	
		3.2	2.00		104		132				11.5	2.97	7.7		21.2	
		3.1	2.40		105		118				6.0167	1.53	8.1		20.3	
		3.7	3.10	2.40	112		120				4.65	1.88	7.6		17.3	
		4.0	2.80	2.80	127		150				2.1667	1.09	7.9		19.1	
		3.6	2.60	2.60	128		144				2.1167	1.00	7.9		19.9	
		5.8	3.70	3.40	152		142				24.333	3.02	7.9		10	
		5.6	4.20	3.50	158		144				11.933	2.98	8.4		11.1	
		5.8	4.10	3.50	127		134				8.2833	2.18	8.1		11.3	
		6.1	3.50	3.00	110		144				17.117	2.68	8.2		12.5	
		5.8	3.30	2.80	102		120				21.233	3.65	8.3		12.4	
		6.1	3.30		117		134				76.667	4.98	8		11.9	
		5.9	4.00	3.50	96		116				13.633	2.39	8.6		15	
		5.6	3.60	2.90	87		124				8.9667	2.18	8.7		14.6	
		5.8	3.70	3.10	98		118				11.55	2.92	8.5		15.5	
		5.3	3.50	3.20	105		126				10.783	2.30	8.3		15.7	
		5.1	3.40	2.70	78		108				8.6833	2.02	7.9		16.1	

Indicate coagulants studied:

ID	Coagulant	Chemical formula	Units
1	Alum	$Al_2(SO_4)_3$*14 H_2O	mg/L
2	Ferric	$FeCl_3$*6 H_2O	mg/L
3			
4			

TREATMENT CONDITIONS

Cl2	Disinfection By-products				Coagulation Conditions					
Conditions	TTHM		HAA5		Coagulant	Dose	Acid	Base	Coag.	Coag.
Chlorine	(µg/L)		(µg/L)		ID		adjusted?	adjusted?	pH	temp.
dose	Raw	Filt.	Raw	Filt.	(see above)		(Y/N)	(Y/N)	()	(deg. C)
(mg Cl2/L)										
2.34		9		6	1	25.1				
2.40		8		6	1	11.8				
2.60		8		4	1	11.6				
2.35		9		5	1	12.8				
2.20		8		6	1	12.5				
1.43		5		5	1	28				
1.57		5		6	1	21.3				
1.49		5		5	1	18.8				
1.32		4		3	1	40				
1.10		5		4	1	31.1				
1.47		4		4	1	29.4				
1.47		8		6	1	24				
1.54		5		4	1	25				
1.60		7		7	1	23.1				
1.90		5		5	1	21.2				
2.00		13		4	1	21				
2.34		9.0		6.0	2	11.2				
2.40		7.6		6.0	2	11.1				
2.60		8.0		4.0	2	8.1				
2.35		8.7		5.0	2	15.9				
2.20		7.8		6.0	2	9.2				
1.43		4.8		5.0	2	16				
1.57		5.1		6.0	2	13.5				
1.49		5.0		5.0	2	10.2				
1.32		3.6		3.0	2	23.8				
1.10		4.8		4.0	2	13.6				
1.47		3.8		4.0	2	26.1				
1.47		8.3		6.0	2	16.7				
1.54		4.9		4.0	2	18.5				
1.60		6.9		7.0	2	18				
1.90		5.4		5.0	2	16.7				
2.00		13.3		4.0	2	18				

Utility ID:				CCWD: Bollman WTP					(ACWD, CCWD, EBMUD, MWD, SCVWD)																										
1. Study ID:				Historical data 7/1/95-6/30/96					(Optimization Study 9/95, etc.)																										
2. Source water:				Delta - Mallard Slough/Rock Slough					(River, lake, groundwater, etc.)																										
3. Source water ID:				Central Valley Project Water					(State Project water, blend of...., etc.)																										
5. Describe level of study:					**Bench-scale**				**In this data sheet, "Filt." refers to data collected**																										
(Indicate with an 'X')					**Pilot-scale**				**after coagulation, flocculation, sedimentation, and**																										
				X	**Full-scale**				**filtration.**																										
6. Indicate with an 'X' if data reported as "Filt." are from samples collected after sedimentation only:																																	
									or after sedimentation and filtration:																										
WATER QUALITY DATA: CONVENTIONAL																																	

Date	**Time**	**TOC (mg/L)**		**UV-254 (1/cm)**		**Alkalinity (mg/L as CaCO3)**		**Hardness (mg/L as CaCO3)**				**Bromide (mg/L)**		**Ammonia (mg NH3-N/L)**		**Chloride (mg Cl-/L)**		**TDS (mg/L)**		**Turbidity (NTU)**		**pH ()**	
								Total		**Calcium**													
		Raw	**Filt.**	**Raw**	**Filt.**	**Raw**	**Filt.**	**Raw**	**Filt.**	**Raw**	**Filt.**	**Raw**	**Filt.**	**Raw**	**Filt.**	**Raw**	**Filt.**	**Raw**	**Filt.**	**Raw**	**Filt.**	**Raw**	**Filt.**
Jul-95						43.9	44.4	47.8	47.9			<0.1	<0.1	<0.1	0.32	21.3	21.3	90	120	3	0.05	7.8	8.8
Aug-95						42.3	42	47.1	46.6				<0.1			20.3	21.3		115	2.4	0.05	8.1	8.9
Sep-95						47.2	48.3	48.4	47.9				<0.1			16.1	16.3		110	2.4	0.05	8	9
Oct-95						52.4	54.2	53.1	54.8			<0.1	<0.1	<0.1	0.25	17.7	18	90	113	3.1	0.05	8.2	9
Nov-95						52.3	51.7	55.1	55.4				<0.1			20	20.4		120	5	0.05	8.4	8.9
Dec-95						54.7	55.5	62	61.3				<0.1			22.3	22.4		130	5.7	0.05	8	8.9
Jan-96						63.2	60.5	71.8	71.5			<0.1	<0.1	<0.1	0.28	29.6	29.6	130	160	6.8	0.05	8.5	9
Feb-96						67.7	67.4	78	75.7				<0.1			33.5	32		195	5.1	0.05	7.8	8.7
Mar-96						64.5	63.8	77.5	76.3				<0.1			34.3	34.3		195	5.5	0.05	8	8.9
Apr-96						63.8	64.3	84.3	82			<0.1	<0.1	<0.1	0.18	36.9	37.5	160	193	5	0.05	8	8.9
May-96						62.5	62.4	88.2	88.8				<0.1			44.8	45.7		210	5.4	0.05	8.2	8.8
Jun-96						54.6	55.8	71.5	73.8				<0.1			35.6	36.5		170	6.4	0.05	8.1	8.9

Temperature (deg. C)		Bromate (µg/L)		Microbial Parameters												Raw					
				Coliforms				Giardia		Crypto.		Viruses		HPC							
Raw	Filt.	Raw	Filt.	Total (#/100mL)		Fecal (#/100mL)		(cysts/100L)		(oocysts/100L)		(#/mL)		(CFU/mL)		Indicate disinfectant(s) used with an 'X'		Chlorine dose	Ammonia dose	Incubation time (h)	
				Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	chlorine	chloramine	(mg Cl2/L)	(mg NH3-N/L)	chlorine	chloramine
	24.8			44	0	7		0	0	0	0			960	0						
	25.2			6	0	3								1750	0						
	23.7			8	0	14								410	0						
	20.8			42	0	5								480	0						
	18.1			29	0	27								3600	0						
	14.3			21	0	3		0	0	0	0			13700	0						
	12.1			26	0	5		0	0	0	0			2100	0						
	14			31	0	16		<5.3		<5.3				160	0						
	15.1			700	0	10		0		0				63700	0						
	17.8			33	0	5		0		0				880	0						
	20.5			37	0	9		0	0	0	<1			1500	0						
	21.8			7	0	1								20400	10						

D—042238

Chlorination conditions												Disinfection By-products							
			Filtered									TTHM (µg/L)		HAA5 (µg/L)		HAA6 (µg/L)		TOX (µg Cl-/L)	
Incub. temp.	pH	Residual	Indicate disinfectant(s) used with an 'X'		Chlorine dose	Ammonia dose	Incubation time (h)		Incub. temp.	pH	Residual	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.
(deg. C)	()	(mg Cl2/L)	chlorine	chloramine	(mg Cl2/L)	(mg NH3-N/L)	chlorine	chloramine	(deg. C)	()	(mg Cl2/L)								
			X	X	1.7	0.37	0.24		24.8	7.2	1.2	<0.5	14.1				7.1		
			X	X	1.6	0.36	0.23		25.2	7.1	1.1		7.8				11.9		
			X	X	1.5	0.3	0.26		23.7	7.3	1.06		8.1				3.9		
			X	X	1.6	0.3	0.3		20.8	7.4	1.07	<0.5	9.8				5.4		
			X	X	1.6	0.33	0.26		18.1	7.4	1.07		14.7				5.1		
			X	X	1.7	0.33	0.54		14.3	7.3	1.07		12.6				6.7		
			X	X	1.8	0.33	0.58		12.1	7.2	1.1	<0.5	16				8.6		
			X	X	1.9	0.31	0.58		14	7.2	1.1		17				7.5		
			X	X	2	0.33	0.52		15.1	7.1	1.12		24.6				6.3		
			X	X	1.9	0.33	0.41		17.8	7.1	1.11	<0.5	24.3				9.8		
			X	X	1.8	0.33	0.31		20.5	7.2	1.17		20.3				12.6		
			X	X	1.8	0.29	0.24		21.8	7.2	0.95		19.3				13.7		
			Note: Disinfection at Bollman is accomplished by a limited free chlorine contact time (see Filtered Incubation Time) followed by chloramination.																
				Typically 90-95% of the CT credit is achieved with free chlorine, the remainder being provided by chloramines'															

Indicate coagulants studied:

ID	Coagulant	Chemical formula	Units
1	Alum	Al2(SO4)3	mg/L
2			
3			
4			

TREATMENT CONDITIONS

Coagulation Conditions

Coagulant ID (see above)	Dose	Acid adjusted? (Y/N)	Base adjusted? (Y/N)	Coag. pH ()	Coag. temp. (deg. C)
1	31.2	Y	N		
1	33.7	Y	N		
1	31.8	Y	N		
1	31.6	Y	N		
1	31.1	Y	N		
1	35.6	Y	N		
1	47.4	Y	N		
1	42.2	Y	N		
1	49.9	Y	N		
1	42.9	Y	N		
1	36.7	Y	N		
1	35.7	Y	N		

D—042240

Contra Costa WD							
Randall-Bold WTP							
Sample	Bromate	Chloride	Bromide				
Date	(measured)	(daily avg)	(estimated)				
	(µg/L)	(mg/L)	(mg/L)				
2/23/93	<0.5	72	0.22				
4/6/93	<1.4	89	0.27				
5/21/93	10	55	0.17				
6/15/93	6	30	<0.1				
8/18/93	6	25	<0.1				
10/5/93	10.3	60	0.18				
11/17/93	30.4	142	0.43				
1/4/94	1.5	70	0.21				
2/9/94	4.6	70	0.21				
3/1/94	2.6	55	0.17				
4/5/94	7.3	77	0.23				
5/10/94	<3	57	0.17				
7/12/94	<5	112	0.34				
8/9/94	<5	133	0.4				
10/4/94	51	158	0.48				
10/10/94	33	118	0.36				
11/1/94	15	150	0.45				
12/6/94	13	162	0.49				
1/10/95	5.7	94	0.28				
2/14/95	17	60	0.18				
3/14/95	7.6	35	0.11				
4/4/95	18	105	0.32				
6/13/95	<5	40	0.12				
7/11/95	21	32	0.1				
8/8/95	7.8	32	0.1				
9/19/95	<5	16	<0.1				
10/3/95	<5	14	<0.1				
11/7/95	<5	16	<0.1				
12/12/95	<5	23	<0.1				
2/6/96	<5	40	0.12				
3/5/96	<5	117	0.35				
Note:	Ozone	dose	currently	optimized	for	coagulation,	
	not	bromate	production.				
Conservative	ozone	doses:	pre-ozone	2.5-3 ppm	(raw water		
			post-ozone	1ppm	(filtered)		
Plant CT operating	from 2-5						

Utility ID:	CCWD, Randall-Bold WTP	(ACWD, CCWD, EBMUD, MWD, SCVWD)	
1. Study ID:	Historical data 7/1/95-6/30/96	(Optimization Study 9/95, etc.)	4. If blended source water indicate sources and proportions:
2. Source water:	Delta (Rock Slough)	(River, lake, groundwater, etc.)	Source / %
3. Source water ID:	Central Valley Project Water	(State Project water, blend of...., etc.)	
	5. Describe level of study: (indicate with an 'X')	Bench-scale	
		Pilot-scale	
	x	Full-scale	

WATER QUALITY DATA: CONVENTIONAL+OZONE

Date	Time	TOC (mg/L)				UV-254 (1/cm)				Alkalinity (mg/L as CaCO3)				Hardness (mg/L as CaCO3)								Bromide (ug/L)				Ammonia (mg NH3-N/L)				Chl (mg
														Total				Calcium												
		Raw	Settl.	Ozon.	Filt.	Raw	Settl.	Ozon.	Filt.	Raw	Settl.	Ozon.	Filt.	Raw	Settl.	Ozon.	Filt.	Raw	Settl.	Ozon.	Filt.	Raw	Settl.	Ozon.	Filt.	Raw	Settl.	Ozon.	Filt.	Raw	Settl.
7/10/95		5.7								37			21	42			43					<0.1			<0.1	0.11			0.35	15	
8/7/95		3.6								36			20	39			45					<0.1			<0.1	<0.1			0.26	12	
9/11/95		7.7								55			48	61			56					<0.1			<0.1	<0.1			0.32	18	
10/2/95		3								58			49	63			49					<0.1			<0.1	<0.1			0.45	15	
11/6/95		2.8								52			43	50			42					<0.1			<0.1	<0.1			0.33	17	
12/4/95		3								55			35	57			55					<0.1			<0.1	0.15			0.44	19	
1/8/96		5.5								62			40	73			75					<0.1			<0.1	<0.1			0.46	26	
2/5/96		6.9								71			36	99			90					0.12			0.11	<0.1			0.51	42	
3/4/96		5.1								107			87	190			181					0.31			0.16	<0.1			0.41	92	
4/1/96		7.8								83			63	129			131					<0.1			0.13	<0.1			0.40	70	
5/6/96										69			51	110			115					0.22			0.19	0.15				60	
6/3/96		4.1								47			35	67			65					0.12			<0.1	<0.1			0.45	25	

Note: Form is set up for conventional filtration and intermediate ozone.
CCWD's Randall-Bold WTP has pre & post ozone and direct filtration.
Raw = Pre-oz
Filt = Post-oz
Settl. = Applied
N/A - not applicable [chlorination is only done after post-ozone process (after filtration)]

Utility ID:																														
1. Study I																														
2. Source																														
3. Source																														
WATER																														

Date	ride		TDS				Turbidity				pH				Temperature				Bromate				Coliforms								Gi
	l-/L)		(mg/L)				(NTU)				()				(deg. C)				(µg/L)				Total				Fecal				(cyst
	Ozon.	Filt.	Raw	Settl.	Ozon.	Filt.	Raw	Settl.	Ozon.	Filt.	Raw	Settl.	Ozon.	Filt.	Raw	Settl.	Ozon.	Filt.	Raw	Settl.	Ozon.	Filt.	(#/100mL)				(#/100mL)				Raw	Settl.
																							Raw	Settl.	Ozon.	Filt.	Raw	Settl.	Ozon.	Filt.		
7/10/95		12	80			110	9.68	8.78		0.032	7.45	6.74		6.56	24.1			23.9				21	190			0	7					
8/7/95		12	70			110	10.87	3.14		0.022	7.43	7.21		6.48	25.2			25.0				7.8	65			0	9				0	
9/11/95		14	110			90	4.59	2.19		0.025	7.57	7.14		6.81	23.7			23.0				<5	77			0	8					
10/2/95		17	100			120	3.60	2.40		0.027	7.55	7.25		7.03	22.7			22.0				<5	41			0	5					
11/6/95		21	90			120	2.52	4.46		0.015	7.73	7.21		7.31	18.0			17.0				<5	46			0	2					
12/4/95		21	100			130	2.67	2.79		0.022	7.82	7.46		7.36	16.5			15.2				<5	65			0	8					
1/8/96		33	140			180	5.20	6.20		0.026	7.52	7.05		6.81	13.0			12.0				<5	61			0	1				0	
2/5/96		61	200			300	6.25	17.25		0.020	7.6	7.12		7.04	14.0			12.8				<5	22			0	3				<1.6	
3/4/96		110	390			390	4.06	6.23		0.062	7.88	7.14		7.01	14.0			13.0				<5	40			0	0					
4/1/96			280			330	3.83	3.08		0.019	8.03	7.24		7.36	16.8			16.0				<5	36			0	4				0	
5/6/96		62	250			290	9.25	10.30		0.018	7.83	6.81		6.71	21.0			21.0				<5	42			0	16				0	
6/3/96		73	120			140	9.55	5.74		0.020	7.59	7.09		7.18	23.5			23.5				<5	28			0	0					

Utility ID:																												
1. Study																												
2. Source																												
3. Source																												
WATER																												

Date	Microbial Parameters														Chlorination conditions													
	dia		Crypto.				Viruses				HPC				Filtered									TTHM				
	/100L)		(oocysts/100L)				(#/mL)				(CFU/mL)				Indicate disinfectant(s)		Chlorine	Ammonia	Incububation time		Incub.	pH	Residual	(µg/L)				
	Ozon.	Filt.	Raw	Settl.	Ozon.	Filt.	Raw	Settl.	Ozon.	Filt.	Raw	Settl.	Ozon.	Filt.	used with an 'X'		dose	dose	(h)		temp.			Raw	Settl.	Ozon.	Filt.
															chlorine	chloramine	(mg Cl2/L)	(mg NH3-N/L)	chlorine	chloramine	(deg. C)	( )	(mg Cl2/L)				
7/10/95		0				0					2100			1		X				3.07	22	9.07	1.00				0.9
8/7/95			0								880			4		X				3.97	23.2	9.00	0.97				<0.5
9/11/95											290			3		X	1.66	0.55		21.7	25	9.08	1.04				<0.5
10/2/95											510			0		X	1.79	0.60		27.1	23.8	9.41	1.06				<0.5
11/6/95											1350			0		X	1.71	0.56		20.3	17	9.05	0.96				<0.5
12/4/95		0				0					810			1		X	1.76	0.58		27.1	15.8	9.34	1.23				<0.5
1/8/96		0	0			0					520			2		X	1.82	0.68		32.5	12.5	8.89	1.10				<0.5
2/5/96			<1.8								880			0		X	1.92	0.67		32.5	12.2	8.92	1.04				<0.5
3/4/96											290			6		X	1.99	0.65		46.5	12.5	8.54	1.08				<0.5
4/1/96		0	0			0					510			1		X	1.77	0.64		20.3	15.6	8.68	1.08				<0.5
5/6/96		0	0			0					430			0		X	1.39	0.47		8.13	20.5	8.56	1.12				<0.5
6/3/96											2950			2		X	1.48	0.49		7.4	22.2	8.76	1.19				<0.5

Utility ID:

1. Study

2. Source

3. Source

WATER

Indicate coagulants studied:

ID	Coagulant	Chemical formula	Units
1	Alum		
2	Cat Poly		
3	Non-Ionic		
4			

TREATMENT CONDITIONS

Date	Disinfection By-products												Coagulation Conditions						Ozonation Conditions					
	HAA5 (µg/L)				HAA6 (µg/L)				TOX (µg Cl-/L)				Coagulant ID	Dose	Acid adjusted?	Base adjusted?	Coag. pH	Coag. temp.	Ozone dose	Post-Ozone Stages 1/2/3 Ozone residual	Per Stage Contact time	Ozone pH	Ozone temp.
	Raw	Settl.	Ozon.	Filt.	Raw	Settl.	Ozon.	Filt.	Raw	Settl.	Ozon.	Filt.	(see above)		(Y/N)	(Y/N)	()	(deg. C)	(mg/L)	(mg/L)	(min)	()	(deg. C)
7/10/95								<2					1/2/3		N	N	6.74	24.1	[redacted]	.38/.23/.3	1.41	7.31	16.2
8/7/95								<1					1/2/3	35 / 1.0 / 0.1	N	N	7.21	25.2	2.5 / 0.5	.34/.27/.3	1.83	6.56	23.9
9/11/95								5					1/2/3	35 / 1.0 / 0.0	N	N	7.14	23.7	1.81 / 0.3	.06/.05/.0	9.98	6.48	25.0
10/2/95								<1					1/2/3	5.7/ 1.2 / 0.0	N	N	7.25	22.7	1.8 / 0.29	.07/.03/.0	12.48	6.81	23.0
11/6/95								<1					1/2/3	9.5/ 1.03 /0.0	N	N	7.21	18.0	1.55 / 0.3	.16/.09/.0	9.36	7.03	21.5
12/4/95								<1					1/2/3	9.9/1.05/0.0	N	N	7.46	16.5	1.9 / 0.4	.14/.10/.0	12.48	7.36	15.2
1/8/96								2					1/2/3	44.7/1.0/0.2	N	N	7.05	13.0	2.85 / 0.3	.12/.04/.0	14.98	6.81	12.0
2/5/96								<2					1/2/3	49.8/1.0/0.2	N	N	7.12	14.0	3.12 / 0.4	.26/.16/.1	14.98	7.04	12.8
3/4/96								<2					1/2/3	77.9/3.0/0.49	N	N	7.14	14.0	3.25 / 1.1	.19/.06/.0	21.39	7.01	13.0
4/1/96								15.6					1/2/3	5.5/0.93/0.1	N	N	7.24	16.8	2.9 / 0.54	.23/.14/.1	9.36	7.36	16.0
5/6/96								2.5					1/2/3	40 / 0.50 /0.0	N	N	6.81	21.0	2.40 / 0.4	.36/.24/.2	3.74	6.71	21.0
6/3/96								<2					1/2/3	27 / 0.48/0.0	N	N	7.09	23.5	1.53 / 0.4	.26/.13/.1	3.40	7.18	23.5

Utility ID:	CCWD Randall-Bold WTP	(ACWD, CCWD, EBMUD, MWD, SCVWD)
1. Study ID:	Historical data 7/1/95-6/30/96	(Optimization Study 9/95, etc.)
2. Source water:	Delta (Rock Slough)	(River, lake, groundwater, etc.)
3. Source water ID:	Central Valley Project Water	(State Project water, blend of..., etc.)

6. Describe level of study: (indicate with an 'X')		
		Bench-scale
		Pilot-scale
	X	Full-scale (see footnotes)

WATER QUALITY DATA: CONVENTIONAL+OZONE

Date	Time	TOC (mg/L) Raw	Alkalinity (mg/L as CaCO3) Raw	Alkalinity Settl.	Alkalinity Ozon.	Alkalinity Filt.	Hardness Total (mg/L as CaCO3) Raw	Hardness Settl.	Hardness Ozon.	Hardness Filt.	Bromide (mg/L) Raw	Bromide Settl.	Bromide Ozon.	Bromide Filt.	Ammonia (mg NH3-N/L) Raw	Ammonia Settl.	Ammonia Ozon.	Ammonia Filt.
2/23/93			76				127			105	0.22				0.024			0.342
4/6/93			96				177			180	0.27				0			0.232
5/21/93			75				104			100	0.17				0.024			0.232
6/15/93			55				66			55	<0.1				0.024			0.378
8/18/93			50				51			51	<0.1				0.024			0.402
10/5/93			83				85			72	0.18				0.02			0.4
11/17/93			58				103			101	0.43				0			0.45
12/8/93			58				89			89					0.012			0.293
1/4/94			80				81			88	0.21				0.085			0.478
2/9/94			68				96			89	0.21				0.012			0.438
3/1/94			75				105			103	0.17				0			0.427
4/5/94			86				135			131	0.23				0			-
5/10/94			81				115			105	0.17				-			-
7/12/94			72				109			105	0.34				0.024			0.41
8/9/94			59				99			96	0.4				0.012			0.33
10/4/94			74				124			122	0.48				0.024			0.36
10/10/94			75				104			106	0.36				0.012			0.451
11/1/94			72				107			108	0.45				0.01			0.34
12/6/94			77				125			134	0.49				0.01			0.44
1/10/95			88				105			102	0.28				0.024			0.378
2/14/95			70				118			136	0.18				-			-
3/14/95			64				103			104	0.11				0.012			0.573
4/4/95			103				170			185	0.32				-			-
6/13/95			40				52			48	0.12				-			-
7/10/95		5.7	37			21	42			43	0.1			<0.1	0.11			0.35
8/7/95		3.6	38			20	39			45	0.1			<0.1	<0.1			0.28
9/11/95		7.7	55			48	61			58	<0.1			<0.1	<0.1			0.32
10/2/95		3	56			49	63			48	<0.1			<0.1	<0.1			0.45
11/6/95		2.8	52			43	50			42	<0.1			<0.1	<0.1			0.33
12/4/95		3	55			35	57			55	<0.1			<0.1	0.15			0.44
1/8/96		5.5	62			40	73			75	<0.1			<0.1	<0.1			0.46
2/5/96		6.9	71			36	99			90	0.12			0.11	<0.1			0.51
3/4/96		5.1	107			87	190			181	0.31			0.18	<0.1			0.41
4/1/96		7.8	83			63	129			131	<0.1			0.13	<0.1			0.40
5/6/96			89			51	110			115	0.22			0.19	0.15			
6/3/96		4.1	47			35	67			85	0.12			<0.1	<0.1			0.45

Date	Chloride (mg Cl-/L) Raw	Chloride Settl.	Chloride Ozon.	Chloride Filt.	TDS (mg/L) Raw	TDS Settl.	TDS Ozon.	TDS Filt.	Turbidity (NTU) Raw	Turbidity Settl.	Turbidity Ozon.	Turbidity Filt.	pH () Raw	pH Settl.	pH Ozon.	pH Filt.	Temperature (deg. C) Raw	Temperature Settl.	Temperature Ozon.	Temperature Filt.	Bromate (µg/L) Raw	Bromate Settl.	Bromate Ozon.	Bromate Filt.	Raw
2/23/93	72								17.5	27.5		0.03	7.5	7.3		6.6	12.9							<5	
4/6/93	80								5.7	12.2		0.068	8.1	7.4		7	17.3							<1.4	
5/21/93	55								12	25.5		0.05	8.8	7.4		6.9	20.2							10	
6/15/93	30								15.9	16.12		0.044	7.5	7.4		6.75	23.5							6	
8/18/93	25								4.5	11.5		0.02	8.55	7.38		6.98	25.4							6	
10/5/93	80								4.57	7.75		0.098	9.1	7.19		6.83	23.4							10.3	
11/17/93	142								1.31	4.52		0.038	7.83	6.85		6.85	17.7							30.4	
12/8/93									1.36	2.7		0.046	7			7.3	12.9			14.3				6.9	
1/4/94	70								2.7	5		0.057	7.2			6.7	11.7			11.8				1.5	
2/9/94	70								1.7	5		0.053	7			6.3	12.4			12.2				4.6	
3/1/94	55								3.8	10.17		0.083	7	6.6		6.6	14.1			13.6				2.6	
4/5/94	77								2.6	11.4		0.071	7.87	7		6.9	17.8			17.6				7.3	
5/10/94	57								1.46	4.15		0.048	7.6	7.14		6.7	20.1			20.7				<3	
7/12/94	112								5.98	14		0.037	7.7	6.98		6.89	25.7			26.1				<5	
8/9/94	133								3	1.97		0.085	7.54	7.3		6.7	26			26.8				<5	
10/4/94	158								6.1	6.3		0.06	7.6	7.3		6.9	22.7			23.3				51	
10/10/94	118								4.6	4.3		0.052	7.8	7.3		6.9	22.4			22.7				33	
11/1/94	150								2.13	2.43		0.051	8.12	7.17		6.96	20.1			19.9				15	
12/6/94	182								2.38	3.01		0.031	7.8	7.4		7.2	13.4			13.4				13	
1/10/95	94								4.7	19		0.038	7.68	7.1		7	12			12				5.7	
2/14/95	80								10.7	22.7		0.028	7.35	6.78		6.68	12.5			12.8				17	
3/14/95	35								8.52	23.5		0.024	7.75	6.93		6.93	14			14.2				7.6	
4/4/95	105								7.23	2.95		0.031	7.86	6.94		6.85	16.3			16.9				18	
6/13/95	40								26	.		0.1	7.56			6.59	24.6			22.2				<5	
7/10/95	32			12	80			110	9.68	6.78		0.032	7.45	6.74		6.58	24.1			23.9				21	190
8/7/95	32			12	70			110	10.87	3.14		0.022	7.43	7.21		6.48	25.2			25.0				7.8	65
9/11/95	16			14	110			90	4.59	2.19		0.025	7.57	7.14		6.81	23.7			23.0				<5	77
10/2/95	14			17	100			120	3.80	2.40		0.027	7.56	7.25		7.03	22.7			22.0				<5	41
11/6/95	16			21	90			120	2.52	4.46		0.015	7.73	7.21		7.31	18.0			17.0				<5	46
12/4/95	23			21	100			130	2.67	2.79		0.022	7.82	7.46		7.36	16.5			15.2				<5	85
1/8/96	26			33	140			180	5.20	6.20		0.026	7.52	7.05		6.81	13.0			12.0				<5	61
2/5/96	42			61	200			300	8.25	17.25		0.020	7.6	7.12		7.04	14.0			12.8				<5	22
3/4/96	82			110	390			390	4.08	6.23		0.062	7.88	7.14		7.01	14.0			13.0				<5	40
4/1/96	70				280			330	3.83	3.08		0.019	8.03	7.24		7.36	16.8			18.0				<5	36
5/6/96	60			62	250			290	9.25	10.30		0.018	7.83	6.81		6.71	21.0			21.0				<5	42
6/3/96	25			73	120			140	9.55	5.74		0.020	7.59	7.09		7.18	23.5			23.5				<5	28

Note: Form is set up for conventional filtration and intermediate ozone

- CCWD's Randall-Bold WTP has pre & post ozone and direct filtration
- Raw = Pre-oz
- Filt = Post-oz
- Settl = Applied
- N/A - not applicable (chlorination is only done after post-ozone process (after filtration))
- At times, the plant has been operated in start-stop manner resulting in higher ozone doses (and bromate) than would have occurred if the plant were operated in a continuous manner (these periods are not marked but could be made available)

D-042246

D-042246

Utility ID:																																					
1. Study																																					
2. Source																																					
3. Source																																					
WATER																																					
Date	Microbial Parameters																								Chlorination conditions												
	Coliforms							Giardia				Crypto.				Viruses				HPC				Filtered										TTHM		
	Total (#/100mL)			Fecal (#/100mL)				(cysts/100L)				(oocysts/100L)				(#/mL)				(CFU/mL)				Indicate disinfectant(s) used with an "X"		Chlorine dose	Ammonia dose	Incubation time (h)		Incub. temp.	pH	Residual	(µg/L)		
	Settl.	Ozon.	Fil.	Raw	Settl.	Ozon.	Fil.	Raw	Settl.	Ozon.	Fil.	Raw	Settl.	Ozon.	Fil.	Raw	Settl.	Ozon.	Fil.	Raw	Settl.	Ozon.	Fil.	chlorine	chloramine	(mg Cl2/L)	(mg NH3-N/L)	chlorine	chloramine	(deg. C)	( )	(mg Cl2/L)	Raw	Settl.	Ozon.
2/23/93																																					
4/6/93																									X	1.3	0.43			6.1	12.7	8.5	0.84			
5/21/93																									X	1.3	0.43			4.5	18.8	8.6	0.77			
6/15/93																									X	1.3	0.43			5.3	20.1	8.4	1.35			
8/18/93																									X	1.1	0.37			3.7	22.9	9	1.17			
10/5/93																									X	1.6	0.53			13.3	25.2	8.68	1.31			
11/17/93																									X	1.3	0.433			4.1	23	8.81	1.19			
12/8/93																									X	1.3	0.433			5.3	15.9	8.84	1.12			
1/4/94																									X	1.3	0.5			27.1	13	8.9	1.18			
2/3/94																									X	1.5	0.48			29.1	11.1	8.9	1.14			
3/1/94																									X	1.5	0.53			28.1	11.8	8.9	1.1			
4/5/94																									X	1.6	0.53			31.3	13.1	8.8	1.08			
5/10/94																									X	1.5	0.51			16.3	17.4	8.7	1.13			
7/13/94																									X	1.2	0.36			9.0	19.9	8.68	1.08			
8/9/94																									X	1.5	0.5			34.7	25.7	8.68	1.29			
10/4/94																									X	1.8	0.6			18.7	26.1	8.57	1.05			
10/13/94																									X	1.35	0.45			5.1	23	8.5	1.19			
11/1/94																									X	1.35	0.45			5.1	22.2	8.7	1.15			
12/6/94																									X	1.35	0.45			5.1	19.3	8.78	1.03			
1/10/95																									X	1.4	0.47			13.6	13.4	8.8	1.16			
2/14/95																									X	1.4	0.47			27.1	11.1	8.8	1.19			
3/14/95																									X	1.5	0.52			20.3	12	8.82	1.34			
4/4/95																									X	1.8	0.52			38.2	13.3	8.74	1.08			
6/13/95																									X	1.6	0.57			16.3	15.1	9.36	0.98			
7/10/95			0	7							0				0					2100			1		X	1.6	0.47			4.3	21.2	8.86	1.25			
8/7/95			0	9				0				0								880			4		X					3.07	22	9.07	1.00			
9/11/95			0	8																290			3		X					3.97	23.2	9.00	0.97			
10/2/95			0	5																510			0		X	1.86	0.55			21.7	25	9.08	1.04			
11/6/95			0	2																1350			0		X	1.79	0.60			27.1	23.8	9.41	1.06			
12/4/95			0	5							0				0					810			1		X	1.71	0.56			20.3	17	9.05	0.98			
1/8/96			0	1				0			0	0			0					520			2		X	1.76	0.58			27.1	15.8	9.34	1.23			
2/5/96			0	3				<1.8				<1.8								880			0		X	1.82	0.68			32.5	12.5	8.89	1.10			
3/4/96			0	0																280			6		X	1.92	0.67			32.6	12.2	8.92	1.04			
4/1/96			0	4				0			0	0			0					510			1		X	1.98	0.65			46.5	12.5	8.54	1.08			
5/6/96			0	16				0			0	0			0					430			0		X	1.77	0.64			20.3	15.6	8.88	1.06			
6/3/96			0	0																2950			2		X	1.39	0.47			8.13	20.5	8.56	1.12			
																									X	1.48	0.49			7.4	22.2	8.78	1.19			
Note:																																					
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D—042247

Utility ID																																
1. Study																																
2. Sourc										Indicate coagulants studied:																					
										ID	Coagulant	Chemical formul		Units																	
3. Sourc										1	Alum																					
										2	Cat Poly																					
										3	Non-Ionic																					
										4																						
WATE										TREATMENT CONDITIONS								Pre/Post		1/2/3			Stage							Post-Ozone Stages	Per
Date	Disinfection By-products									Coagulation Conditions								Ozonation Conditions														
	HAA5 (ug/L)					TOX (ug Cl-/L)				Coagulant ID	Dose			Acid ajuste	Base adjusted	Coag. pH	Coag. temp.	Ozone dose (mg/L)		Ozone residual (mg/L)			Contact time	Ozone pH	Ozone temp.							
	FIR.	Raw	Settl.	Ozon.	FIR.	Raw	Settl.	Ozon.	FIR.	(see above)	1	2	3	(Y/N)	(Y/N)	()	(deg. C)	Pre	Post	1	2	3	(mins)	()	(deg. C)							
2/23/93										1/2/3	55	3	0.1	N	N	7.3	12.9	0.00	0.70	0.3	0.29	0.29	2.79	6.6								
4/6/93										1/2/3	37		0.14	N	N	7.4	17.3	2.00	1.00	0.51	0.28	0.28	2.05	7								
5/21/93										1/2/3	45	4		N	N	7.4	20.2	2.75	1.10	0.26	0.2	0.2	2.42	6.9								
6/15/93										1/2/3	24		0.12	N	N	7.4	23.5	2.00	0.90	0.29	0.18	0.18	1.89	6.75								
8/18/93										1/2/3	37	2	0.2	N	N	7.38	25.4			0.56	0.15	0.15	6.14	6.98								
10/5/93										1/2/3	26		0.2	N	N	7.19	23.4	1.75	0.60	0.35	0.1	0.1	1.86	6.83								
11/17/93										1/2/3	24		0.2	N	N	6.96	17.7	1.50	0.45		0.46	0.45	2.42	6.85								
12/8/93										1/2/3	20		0.93	N	N		12.9	1.50	0.40		0.26	0.14	12.48	7.3	14.3								
1/14/94										1/2/3	23.5		0.2	N	N		11.7	1.50	0.35		0.16	0.19	13.37	6.7	11.6								
2/9/94										1/2/3	30	2		N	N		12.4	1.50	0.35	0.13	0.05	0.03	12.91	6.3	12.2								
3/1/94										1/2/3	30	2.1	0.073	N	N	6.6	14.1	2.50	0.45	0.18	0.09	0.04	14.4	6.6	13.6								
4/5/94										1/2/3	38	1	0.08	N	N	7	17.8	2.50	0.86	0.13	0.09	0.09	7.49	6.9	17.6								
5/10/94										1/2/3	34	0.7	0.08	N	N	7.14	20.1	1.75	0.30	0.35	0.15	0.12	4.16	6.7	20.7								
7/12/94										1/2/3	31	0.8	0.075	N	N	6.98	25.7	3.50	0.35	0.15	0.05	0.04	11.35	6.89	25.1								
8/8/94										1/2/3	23	0.66	0.08	N	N	7.3	26	2.50	0.40	0.12	0.04	0.02	8.61	6.7	25.8								
10/4/94										1/2/3	14	1.7	0.075	N	N	7.3	22.7	2.50	0.40	0.27	0.23	0.15	2.34	6.9	23.3								
10/10/94										1/2/3	14	1.7	0.075	N	N	7.3	22.4	1.70	0.40	0.27	0.28	0.19	2.34	6.8	22.7								
11/1/94										1/2/3	14	1.7	0.075	N	N	7.17	20.1	1.50	0.40	0.1	0.15	0.16	2.34	6.96	19.9								
12/6/94										1/2/3	18	1	0.075	N	N	7.4	13.4	2.00	0.40	0.33	0.21	0.14	6.24	7.2	13.4								
1/10/95										1/2/3	30	1	0.1	N	N	7.1	12	2.00	0.43	0.22	0.08	0.08	12.48	7	12								
2/14/95										1/2/3	71	3.35	0.25	N	N	6.78	12.5	3.00	0.85	0.1	0.07	0.06	9.36	6.68	12.8								
3/14/95										1/2/3	40	1.13	0.11	N	N	6.93	14	2.00	0.40	0.16	0.1	0.07	16.64	6.93	14.2								
4/4/95										1/2/3	67	1	0.11	N	N	6.94	16.3	2.50	0.80	0.27	0.09	0.09	7.49	6.85	16.9								
6/13/95										1/2/3	30	1	0.1	N	N		24.6	2.50	0.80	0.32	0.12	0.24	1.97	6.58	22.2								
7/10/95	0.9				<2					1/2/3				N	N	6.74	24.1			0.36	0.23	0.37	1.41	7.31	16.2								
8/7/95	<0.5				<1					1/2/3	35	1	.1	N	N	7.21	25.2	2.50	0.50	0.34	0.27	0.3	1.83	6.56	23.9								
9/11/95	<0.5				5					1/2/3	35	1	.06	N	N	7.14	23.7	1.81	0.31	0.06	0.05	0.04	9.96	6.46	25.0								
10/2/95	<0.5				<1					1/2/3	15	1.2	.06	N	N	7.26	22.7	1.80	0.29	0.07	0.03	0.02	12.48	6.81	23.0								
11/6/95	<0.5				<1					1/2/3	19.5	1.03	.05	N	N	7.21	18.0	1.56	0.30	0.18	0.09	0.09	9.36	7.03	21.5								
12/4/95	<0.5				<1					1/2/3	19.9	1.06	.05	N	N	7.46	16.5	1.80	0.40	0.14	0.1	0.06	12.48	7.36	15.2								
1/8/96	<0.5				2					1/2/3	44.7	1	.2	N	N	7.05	13.0	2.85	0.58	0.12	0.04	0.03	14.98	6.81	12.0								
2/5/96	<0.5				<2					1/2/3	48.8	1	.2	N	N	7.12	14.0	3.12	0.45	0.26	0.16	0.13	14.98	7.04	12.8								
3/4/96	<0.5				<2					1/2/3	77.9	3	.49	N	N	7.14	14.0	3.25	1.15	0.18	0.06	0.01	21.39	7.01	13.0								
4/1/96	<0.5				15.8					1/2/3	45.5	.93	.19	N	N	7.24	16.8	2.90	0.54	0.23	0.14	0.13	9.36	7.36	16.0								
5/6/96	<0.5				2.5					1/2/3	40	0.5	0.02	N	N	6.81	21.0	2.40	0.43	0.36	0.24	0.26	3.74	6.71	21.0								
6/3/96	<0.5				<2					1/2/3	27	.48	.01	N	N	7.09	23.5	1.53	0.43	0.26	0.13	0.18	3.40	7.18	23.5								
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Utility ID:	EBMUD (ACWD, CCWD, EBMUD, MWD, SCVWD)
1. Study ID:	EBMUD Alternate Source Study (Optimization Study 9/95, etc.)
2. Source water:	(American) River (River, lake, groundwater, etc.)
3. Source water ID:	(State Project water, etc.)

5. Describe point of reference for which water quality data are being supplied, i.e. upstream and downstream of City of Sacramento combined sewage discharge, etc.

Nimbus Dam, American River

If entering data on seasonal changes in plant raw source water quality, use upstream column.

WATER QUALITY DATA: RAW

Date	Time	TOC (mg/L)		Alkalinity (mg/L as CaCO		Hardness (mg/L as CaCO3) Total		Bromide		Ammonia (mg NH3-N/L)		Chloride (mg Cl-/L)		TDS (mg/L)		Turbidity (NTU)		pH ()		Temperature (deg. C)		Microbial Parameters Coliforms Total (#/100mL)		Fecal (#/100mL)	
		Upstr.	Down.	Upstr.	Down.	Upstr.	Down.	Upstr.	Down.	Upstr.	Down.	Upstr.	Down	Upstr.	Down.	Upstr.	Down.	Upstr.	Down.	Upstr.	Down.	Upstr.	Down.	Upstr.	Down.
1/17/89		2.4		32		33		<0.005		0.009		4		59		1.6		7.7		8		26		11	
2/14/89		1.6		31		32		<0.03		0.01		5		60		0.98		7.8		8		50		11	
3/13/89		2.8		33		35		<0.02		0.01		4		64		3.5		7.6		11		430		140	
4/17/89		1.8		27		28		<0.05		0.016		3		53		2.3		8.1		15		800		500	
5/15/89		1.9		24		25		<0.05		<0.005		3		50		1.5		7.8		18		210		30	
6/19/89		1.9		24		22		<0.05		0.04		2		45		1.1		7.6		18		170		30	
6/19/89		2.3		25		120						13		47		1.2						170		80	
6/19/89				120																		500		130	
7/17/89		1.4		21		22		<0.03		<0.005		2		46		0.7		7.5		24		1300		300	
8/14/89		35		24		21		<0.05		0.005		6		44		0.82		7.4		24.5		300		80	
9/25/89		1.4		21		20		<0.01				4		44		0.45		7.5		20		220		130	
11/13/89		1.7		21		21		0.01		<0.005		2		44		1.1		7.4		16		80		80	
12/11/89		1.3		29		24		<0.01		0.01		2		47		2.5		7.4		11		1100		800	
12/11/89																						2200		2200	
1/22/90		1.3		23		24		<0.01		<0.005		2		49		1.3		7.6		9		110		110	
2/20/90		1.8		25		26		<0.02		0.007		4		50		5.5		7.7		8		800		300	
3/5/90		1.3		36		32		0.01				5		57		1.6		7.8		11.5		17		4	
4/9/90		1.2		31		29		<0.01		<0.005		4		53		0.57		7.8		17.5		80		50	
5/21/90		1.4						0.01				3		54		0.64						280			
6/25/90		1.3		27		27		<0.05		0.03		3		51		0.38		7.5		17.5		80		80	
7/16/90		1.3						<0.01				4		48		0.5						11			
8/20/90		1.4						0.02				2		43		2.5									
9/17/90		1.4						0.01				2		39		0.95						80			
10/15/90		1.5		21		18		0.11				2		40		0.77		7.4		20		50		30	
10/15/90		1.6		22		20		<0.01								0.8						170		70	
11/26/90		1.5						<0.01				4		43		0.94						500			
12/17/90		1.5						<0.01				4		47		3.1						70			
1/7/91		1.2		25		21		<0.01				3		34		1.3		7.6				50		50	
1/7/91		1.3		27								4				1.6						110		110	
2/11/91		1.7		30		25		0.02				6		50		4.1		7.2		13		130		50	
3/11/91		2.3		27		32		0.01		0.01		4		58		3.4		7.6		12		1700		500	
3/11/91										0.08															
4/8/91		3.2		36		39		0.01		0.01		4		68				8.6		16		50		23	
5/20/91		1.9		32		32		0.01		<0.02		2		59		1.6		8.2		19.5		800		500	
6/17/91		1.9		26		26		<0.01				3		51		1.8		7.6		21.5		70		11	
6/17/91																								23	
7/8/91		1.3		28		25		<0.01				2		50		1.2		7.8		20.5		90		30	
7/8/91		1.7		32		31						3		51		1.5		8.4				500		80	
7/8/91												13				1.6									
8/19/91		1.5		27		23		<0.01				2		46		1.1		7.6		23.5		50		17	
8/19/91		1.6		28		24						3		49								60		23	
9/16/91				24		22		<0.01				4		55		0.6		7.6		24		350		30	
9/16/91												14													
10/15/91		1.6		25		21		0.07		0.02		3		45		1.1		7.4		20.5		110		80	
10/15/91								<0.01																	
11/18/91		1.4		27		25		0.02		0.01		3		48		1.2		7.6		15		130		23	
11/18/91								0.1																	
12/16/91		1.7		26		23		<0.05				2		44		0.79		7.6		11		70		70	

Utility ID:			MWD				(ACWD, CCWD, EBMUD, MWD, SCVWD)												
1. Study ID:			Jar Tests--range of %SPW/%CRW				(Optimization Study 9/95, etc.)						Indicate coagulants studied:						
													ID	Coagulant	Chemical formula				Units
2. Source water:			Surface				(River, lake, groundwater, etc.)						1	Alum	$Al_2(SO_4)_3$*14 H_2O				mg/L
													2	Polymer	Cationic				mg/L
3. Source water ID:			SPW, CRW				(State Project water, blend of...., etc.)						3						
													4						
5. Describe level of study:			X	Bench-scale			In this data sheet, "Filt." refers to data collected						Doses include usually 3 (sometimes 2) mg/L polymer						
(indicate with an 'X')				Pilot-scale			after coagulation, flocculation, sedimentation, and												
				Full-scale			filtration.												
6. Indicate with an 'X' if data reported as "Filt." are from samples collected after sedimentation only:													X	60 min settling time					
or after sedimentation and filtration:																			
WATER QUALITY DATA: CONVENTIONAL																			
													TREATMENT CONDITIONS						
Study ID	Water		TOC		UV-254		Alkalinity		Turbidity		pH		Coagulation Conditions						
	% CRW	% SPW	(mg/L)		(1/cm)		(mg/L as CaCO3)		(NTU)		()		Coagulant	Dose	Acid	Base	Coag.		
			Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	ID		adjusted?	adjusted?	pH		
													(see above)		(Y/N)	(Y/N)	()		
															blank=N	blank=N			
MWDJAR01	100		2.42	2.43	0.025		123		0.74	0.74	8.03		1	0			8.06		
MWDJAR01	100		2.42	2.32	0.025	0.039	123		0.74	0.43	8.03		1	10			7.71		
MWDJAR01	100		2.42	2.27	0.025	0.036	123		0.74	0.54	8.03		1	20			7.44		
MWDJAR01	100		2.42	2.17	0.025	0.035	123		0.74	0.68	8.03		1	30			7.30		
MWDJAR01	100		2.42	2.02	0.025	0.013	123		0.74		8.03		1	40			7.24		
MWDJAR01	100		2.42	1.95	0.025	0.038	123		0.74	0.90	8.03		1	50			6.89		
MWDJAR01	100		2.42	1.86	0.025	0.034	123		0.74	0.82	8.03		1	60			6.81		
MWDJAR01	100		2.42	1.88	0.025	0.036	123		0.74	0.87	8.03		1	70			6.72		
MWDJAR06	100		2.25	2.20	0.019	0.019	132		0.65	0.62	8.29		1	0			8.29		
MWDJAR06	100		2.25	2.12	0.019	0.013	132		0.65	0.56	8.29		1	10			7.88		
MWDJAR06	100		2.25	1.97	0.019	0.011	132		0.65	0.51	8.29		1	20			7.67		
MWDJAR06	100		2.25	1.95	0.019	0.009	132		0.65	0.43	8.29		1	30			7.49		
MWDJAR06	100		2.25	1.83	0.019	0.007	132		0.65	0.62	8.29		1	40			7.33		
MWDJAR06	100		2.25	1.67	0.019	0.004	132		0.65	0.79	8.29		1	50			7.24		
MWDJAR06	100		2.25	1.88	0.019	0.004	132		0.65	0.74	8.29		1	60			7.00		
MWDJAR06	100		2.25	1.67	0.019	0.003	132		0.65	0.90	8.29		1	70			6.93		
MWDJAR06	100		2.25	1.61	0.019	0.002	132		0.65	1.00	8.29		1	80			6.84		
MWDJAR06	100		2.25	1.56	0.019	0.001	132		0.65	1.20	8.29		1	90			6.75		
MWDJAR06	100		2.25	1.52	0.019	0.001	132		0.65	1.40	8.29		1	100			6.67		
MWDJAR06	100		2.25	1.47	0.019	0.001	132		0.65	1.30	8.29		1	110			6.57		
MWDJAR07	100		2.39	2.41	0.036	0.038	132		0.42	0.34	8.34		1	0			8.15		
MWDJAR07	100		2.39	2.28	0.036	0.033	132		0.42	0.34	8.34		1	10			7.88		
MWDJAR07	100		2.39	2.11	0.036	0.032	132		0.42	0.36	8.34		1	20			7.71		
MWDJAR07	100		2.39	1.99	0.036	0.028	132		0.42	0.32	8.34		1	30			7.56		
MWDJAR07	100		2.39	1.94	0.036	0.025	132		0.42	0.34	8.34		1	40			7.46		
MWDJAR07	100		2.39	1.78	0.036	0.023	132		0.42	0.42	8.34		1	50			7.38		
MWDJAR07	100		2.39	1.76	0.036	0.023	132		0.42	0.49	8.34		1	60			7.25		
MWDJAR07	100		2.39	1.60	0.036	0.023	132		0.42	0.57	8.34		1	70			7.22		
MWDJAR07	100		2.39	1.68	0.036	0.027	132		0.42	0.59	8.34		1	80			7.10		
MWDJAR07	100		2.39	1.63	0.036	0.021	132		0.42	0.60	8.34		1	90			7.06		
MWDJAR07	100		2.39	1.65	0.036	0.019	132		0.42	0.67	8.34		1	100			6.98		
MWDJAR08	100		2.45	2.56	0.030	0.033	122		0.40	0.40	8.18		1	0			7.98		
MWDJAR08	100		2.45	2.44	0.030	0.031	122		0.40	0.32	8.18		1	10			7.85		
MWDJAR08	100		2.45	2.26	0.030	0.031	122		0.40	0.25	8.18		1	20			7.72		
MWDJAR08	100		2.45	2.14	0.030	0.026	122		0.40	0.28	8.18		1	30			7.61		
MWDJAR08	100		2.45	2.06	0.030	0.025	122		0.40	0.68	8.18		1	40			7.52		
MWDJAR08	100		2.45	2.03	0.030	0.026	122		0.40	0.33	8.18		1	50			7.45		
MWDJAR08	100		2.45	2.01	0.030	0.024	122		0.40	0.34	8.18		1	60			7.35		
MWDJAR08	100		2.45	2.00	0.030	0.021	122		0.40	0.35	8.18		1	70			7.26		
MWDJAR08	100		2.45	1.87	0.030	0.020	122		0.40	0.50	8.18		1	80			7.17		
MWDJAR08	100		2.45	1.79	0.030	0.020	122		0.40	0.48	8.18		1	90			7.06		
MWDJAR08	100		2.45	1.78	0.030	0.019	122		0.40	0.55	8.18		1	100			6.98		
MWDJAR09	90		2.55	2.55	0.055		119		0.71	0.62	7.97		1	0			7.97		
MWDJAR09	90		2.55	2.51	0.055	0.046	119		0.71	0.40	7.97		1	10			7.66		
MWDJAR09	90		2.55	2.46	0.055	0.036	119		0.71	0.34	7.97		1	20			7.48		
MWDJAR09	90		2.55	2.23	0.055	0.041	119		0.71	0.41	7.97		1	30			7.34		
MWDJAR09	90		2.55	2.19	0.055	0.031	119		0.71	0.33	7.97		1	40			7.21		
MWDJAR09	90		2.55	2.00	0.055	0.034	119		0.71	0.42	7.97		1	50			6.89		
MWDJAR09	90		2.55	1.92	0.055	0.032	119		0.71	0.42	7.97		1	60			6.85		
MWDJAR09	90		2.55	2.01	0.055		119		0.71		7.97		1	70			6.79		
MWDJAR09	90		2.55	1.98	0.055		119		0.71		7.97		1	80			6.62		
MWDJAR09	90		2.55	1.87	0.055		119		0.71		7.97		1	90			6.58		
MWDJAR09	90		2.55	1.95	0.055		119		0.71		7.97		1	100			6.50		
MWDJAR09	90		2.55	1.84	0.055		119		0.71		7.97		1	110			6.41		
MWDJAR09	90		2.55	1.87	0.055		119		0.71		7.97		1	120			6.18		
MWDJAR10	90		2.58	2.52	0.055	0.046	125		0.64	0.55	8.22		1	0			8.26		
MWDJAR10	90		2.58	2.42	0.055	0.036	125		0.64	0.60	8.22		1	10			7.74		
MWDJAR10	90		2.58	2.23	0.055	0.041	125		0.64	0.66	8.22		1	20			7.49		
MWDJAR10	90		2.58	2.04	0.055	0.031	125		0.64	0.48	8.22		1	30			7.28		
MWDJAR10	90		2.58	2.12	0.055	0.034	125		0.64	0.78	8.22		1	40			7.15		
MWDJAR10	90		2.58	1.83	0.055	0.032	125		0.64	0.86	8.22		1	50			6.98		
MWDJAR10	90		2.58	2.01	0.055	0.027	125		0.64	0.75	8.22		1	60			7.15		
MWDJAR10	90		2.58	2.03	0.055	0.030	125		0.64	0.63	8.22		1	70			7.04		
MWDJAR10	90		2.58	1.95	0.055	0.026	125		0.64	0.68	8.22		1	80			6.88		
MWDJAR10	90		2.58	1.92	0.055	0.027	125		0.64	0.88	8.22		1	90			6.82		
MWDJAR10	90		2.58	1.76	0.055	0.036	125		0.64	1.30	8.22		1	100			6.75		
MWDJAR10	90		2.58	1.82	0.055	0.028	125		0.64	1.30	8.22		1	110			6.77		
MWDJAR11	90		2.67	2.63	0.053	0.048	128		0.49	0.45	8.33		1	0			8.40		
MWDJAR11	90		2.67	2.60	0.053	0.037	128		0.49	0.56	8.33		1	10			7.89		
MWDJAR11	90		2.67	2.44	0.053	0.029	128		0.49	0.60	8.33		1	20			7.64		
MWDJAR11	90		2.67	2.21	0.053	0.025	128		0.49	0.46	8.33		1	30			7.41		
MWDJAR11	90		2.67	2.22	0.053	0.026	128		0.49	0.72	8.33		1	40			7.21		
MWDJAR11	90		2.67	2.00	0.053	0.024	128		0.49	0.70	8.33		1	50			7.08		
MWDJAR11	90		2.67	1.77	0.053	0.022	128		0.49	0.78	8.33		1	60			6.93		
MWDJAR11	90		2.67	1.72	0.053	0.023	128		0.49	0.78	8.33		1	70			6.83		

Study ID	Water		TOC		UV-254		Alkalinity		Turbidity		pH		Coagulation Conditions				
	% CRW	% SPW	(mg/L)		(1/cm)		(mg/L as CaCO3)		(NTU)		()		Coagulant	Dose	Acid	Base	Coag.
			Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	ID		adjusted?	adjusted?	pH
													(see above)		(Y/N)	(Y/N)	()
															blank=N	blank=N	
MWDJAR11	90		2.67	1.66	0.053	0.026	128		0.49	0.85	8.33		1	80			6.72
MWDJAR11	90		2.67	1.67	0.053	0.022	128		0.49	1.10	8.33		1	90			6.62
MWDJAR12	90		2.95	3.00	0.042	0.043	120		0.67	0.30	8.23		1	0			8.20
MWDJAR12	90		2.95	2.76	0.042	0.032	120		0.67	0.28	8.23		1	10			7.80
MWDJAR12	90		2.95	2.63	0.042	0.032	120		0.67	0.22	8.23		1	20			7.66
MWDJAR12	90		2.95	2.50	0.042	0.031	120		0.67	0.21	8.23		1	30			7.44
MWDJAR12	90		2.95	2.35	0.042	0.029	120		0.67	0.23	8.23		1	40			7.26
MWDJAR12	90		2.95	2.33	0.042	0.029	120		0.67	0.23	8.23		1	50			7.23
MWDJAR12	90		2.95	2.12	0.042	0.032	120		0.67	0.24	8.23		1	60			7.16
MWDJAR12	90		2.95	2.01	0.042	0.029	120		0.67	0.20	8.23		1	70			7.08
MWDJAR12	90		2.95	1.95	0.042	0.029	120		0.67	0.25	8.23		1	80			7.01
MWDJAR12	90		2.95	1.90	0.042	0.027	120		0.67	0.23	8.23		1	90			6.88
MWDJAR12	90		2.95	1.86	0.042	0.028	120		0.67	0.29	8.23		1	100			6.82
MWDJAR12	90		2.95	1.82	0.042	0.027	120		0.67	0.27	8.23		1	110			6.79
MWDJAR12	90		2.95	1.74	0.042	0.028	120		0.67	0.47	8.23		1	120			6.76
MWDJAR12	90		2.95	1.70	0.042	0.028	120		0.67	0.56	8.23		1	130			6.67
MWDJAR12	90		2.95	1.71	0.042	0.026	120		0.67	0.52	8.23		1	140			6.61
MWDJAR12	90		2.95	1.62	0.042	0.026	120		0.67	0.45	8.23		1	150			6.47
MWDJAR12	90		2.95	1.61	0.042	0.027	120		0.67	0.49	8.23		1	160			6.40
MWDJAR12	90		2.95	1.54	0.042	0.027	120		0.67	0.55	8.23		1	170			6.37
MWDJAR12	90		2.95	1.62	0.042	0.028	120		0.67	1.30	8.23		1	180			6.23
MWDJAR12	90		2.95	1.57	0.042	0.026	120		0.67	1.30	8.23		1	190			6.18
MWDJAR12	90		2.95	1.69	0.042	0.052	120		0.67	3.80	8.23		1	200			6.12
MWDJAR13	90		2.25	2.26	0.034	0.035	126		0.77	0.77	8.30		1	0			8.28
MWDJAR13	90		2.25	2.08	0.034	0.023	126		0.77	0.48	8.30		1	10			7.90
MWDJAR13	90		2.25	1.86	0.034	0.021	126		0.77	0.40	8.30		1	20			7.72
MWDJAR13	90		2.25	2.00	0.034	0.019	126		0.77	0.38	8.30		1	30			7.56
MWDJAR13	90		2.25	1.92	0.034	0.018	126		0.77	0.46	8.30		1	40			7.43
MWDJAR13	90		2.25	1.86	0.034	0.018	126		0.77	0.45	8.30		1	50			7.33
MWDJAR13	90		2.25	1.80	0.034	0.018	126		0.77	0.58	8.30		1	60			7.20
MWDJAR13	90		2.25	1.76	0.034	0.015	126		0.77	0.57	8.30		1	70			7.14
MWDJAR13	90		2.25	1.66	0.034	0.013	126		0.77	0.58	8.30		1	80			7.06
MWDJAR13	90		2.25	1.62	0.034	0.013	126		0.77	0.55	8.30		1	90			6.98
MWDJAR13	90		2.25	1.52	0.034	0.012	126		0.77	0.67	8.30		1	100			6.94
MWDJAR13	90		2.25	1.51	0.034	0.012	126		0.77	0.78	8.30		1	110			6.88
MWDJAR14	90		2.31	2.48	0.033	0.033	127		0.58	0.54	8.20		1	0			8.22
MWDJAR14	90		2.31	2.45	0.033	0.025	127		0.58	0.55	8.20		1	10			7.95
MWDJAR14	90		2.31	2.38	0.033	0.023	127		0.58	0.44	8.20		1	20			7.71
MWDJAR14	90		2.31	2.21	0.033	0.021	127		0.58	0.48	8.20		1	30			7.52
MWDJAR14	90		2.31	2.09	0.033	0.020	127		0.58	0.67	8.20		1	40			7.40
MWDJAR14	90		2.31	1.98	0.033	0.018	127		0.58	0.39	8.20		1	50			7.31
MWDJAR14	90		2.31	1.77	0.033	0.017	127		0.58	0.68	8.20		1	60			7.27
MWDJAR14	90		2.31	1.74	0.033	0.015	127		0.58	0.77	8.20		1	70			7.13
MWDJAR14	90		2.31	1.67	0.033	0.017	127		0.58	0.82	8.20		1	80			7.06
MWDJAR14	90		2.31	1.60	0.033	0.015	127		0.58	0.70	8.20		1	90			6.93
MWDJAR14	90		2.31	1.55	0.033	0.015	127		0.58	0.95	8.20		1	100			6.84
MWDJAR14	90		2.31	1.52	0.033	0.014	127		0.58	1.00	8.20		1	110			6.77
MWDJAR14	90		2.31	1.49	0.033	0.015	127		0.58	1.00	8.20		1	120			6.60
MWDJAR14	90		2.31	1.46	0.033	0.016	127		0.58	1.00	8.20		1	130			6.53
MWDJAR14	90		2.31	1.48	0.033		127		0.58		8.20		1	140			
MWDJAR14	90		2.31	1.42	0.033		127		0.58		8.20		1	150			
MWDJAR14	90		2.31	1.33	0.033		127		0.58		8.20		1	160			
MWDJAR15	90		3.17	2.51	0.036	0.041	127		0.47	0.35	8.29		1	0			8.30
MWDJAR15	90		3.17	2.37	0.036	0.034	127		0.47	0.54	8.29		1	10			7.96
MWDJAR15	90		3.17	2.24	0.036	0.031	127		0.47	0.39	8.29		1	20			7.74
MWDJAR15	90		3.17	2.06	0.036	0.028	127		0.47	0.27	8.29		1	30			7.52
MWDJAR15	90		3.17	2.01	0.036	0.026	127		0.47	0.59	8.29		1	40			7.39
MWDJAR15	90		3.17	1.86	0.036	0.028	127		0.47	0.56	8.29		1	50			7.32
MWDJAR15	90		3.17	1.76	0.036	0.025	127		0.47	0.58	8.29		1	60			7.23
MWDJAR15	90		3.17	1.72	0.036	0.024	127		0.47	0.65	8.29		1	70			7.15
MWDJAR15	90		3.17	1.66	0.036	0.024	127		0.47	0.77	8.29		1	80			7.06
MWDJAR15	90		3.17	1.54	0.036	0.024	127		0.47	0.63	8.29		1	90			7.03
MWDJAR15	90		3.17	1.58	0.036	0.022	127		0.47	0.78	8.29		1	100			6.93
MWDJAR16	90		2.43	2.52	0.041	0.042	117		0.42	0.32	8.25		1	0			8.28
MWDJAR16	90		2.43	2.50	0.041	0.031	117		0.42	0.35	8.25		1	10			8.01
MWDJAR16	90		2.43	2.32	0.041	0.026	117		0.42	0.28	8.25		1	20			7.80
MWDJAR16	90		2.43	2.19	0.041	0.025	117		0.42	0.24	8.25		1	30			7.68
MWDJAR16	90		2.43	2.05	0.041	0.024	117		0.42	0.27	8.25		1	40			7.55
MWDJAR16	90		2.43	2.06	0.041	0.024	117		0.42	0.30	8.25		1	50			7.44
MWDJAR16	90		2.43	1.99	0.041	0.022	117		0.42	0.30	8.25		1	60			7.36
MWDJAR16	90		2.43	1.92	0.041	0.021	117		0.42	0.35	8.25		1	70			7.27
MWDJAR16	90		2.43	1.87	0.041	0.021	117		0.42	0.33	8.25		1	80			7.16
MWDJAR16	90		2.43	1.82	0.041	0.021	117		0.42	0.36	8.25		1	90			7.07
MWDJAR16	90		2.43	1.85	0.041	0.021	117		0.42	0.36	8.25		1	100			7.00
MWDJAR16	90		2.43	1.75	0.041	0.020	117		0.42	0.39	8.25		1	110			6.84
MWDJAR16	90		2.43	1.73	0.041	0.019	117		0.42	0.46	8.25		1	120			6.77
MWDJAR16	90		2.43	1.76	0.041	0.018	117		0.42	0.55	8.25		1	130			6.65
MWDJAR16	90		2.43	1.65	0.041	0.018	117		0.42	0.53	8.25		1	140			6.61
MWDJAR16	90		2.43	1.68	0.041	0.017	117		0.42	0.62	8.25		1	150			6.51
MWDJAR16	90		2.43	1.60	0.041	0.016	117		0.42	0.80	8.25		1	160			6.50
MWDJAR16	90		2.43	1.49	0.041	0.015	117		0.42	0.91	8.25		1	170			6.61
MWDJAR16	90		2.43	1.61	0.041	0.014	117		0.42	1.10	8.25		1	180			6.48
MWDJAR16	90		2.43	1.64	0.041	0.013	117		0.42	1.10	8.25		1	190			6.38
MWDJAR16	90		2.43	1.55	0.041	0.014	117		0.42	1.40	8.25		1	200			6.26
MWDJAR16	90		2.43	1.52	0.041	0.013	117		0.42	0.93	8.25		1	210			6.18
MWDJAR16	90		2.43	1.58	0.041	0.013	117		0.42	1.10	8.25		1	220			6.12
MWDJAR17	80		2.55	2.55	0.061		114		1.20	1.20	8.09		1	0			8.04
MWDJAR17	80		2.55	2.61	0.061	0.048	114		1.20	0.49	8.09		1	10			7.68
MWDJAR17	80		2.55	2.55	0.061	0.042	114		1.20	0.41	8.09		1	20			7.46
MWDJAR17	80		2.55	2.39	0.061	0.041	114		1.20	0.34	8.09		1	30			7.24
MWDJAR17	80		2.55	2.39	0.061	0.034	114		1.20	0.61	8.09		1	40			7.15
MWDJAR17	80		2.55	2.13	0.061	0.033	114		1.20	0.39	8.09		1	50			7.01

Study ID	Water		TOC		UV-254		Alkalinity		Turbidity		pH		Coagulation Conditions				
	% CRW	% SPW	(mg/L)		(1/cm)		(mg/L as CaCO3)		(NTU)		()		Coagulant	Dose	Acid	Base	Coag.
			Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	ID		adjusted?	adjusted?	pH
													(see above)		(Y/N)	(Y/N)	()
															blank=N	blank=N	
MWDJAR17	80		2.55	2.02	0.061	0.034	114		1.20	0.44	8.09		1	60			6.95
MWDJAR17	80		2.55	1.96	0.061	0.042	114		1.20	1.10	8.09		1	70			6.60
MWDJAR17	80		2.55	1.84	0.061	0.032	114		1.20	0.95	8.09		1	80			6.51
MWDJAR17	80		2.55	1.74	0.061	0.031	114		1.20	0.85	8.09		1	90			6.43
MWDJAR17	80		2.55	1.64	0.061	0.033	114		1.20	1.40	8.09		1	100			6.27
MWDJAR17	80		2.55	1.67	0.061	0.033	114		1.20	1.20	8.09		1	110			6.17
MWDJAR17	80		2.55	1.62	0.061	0.033	114		1.20	1.30	8.09		1	120			6.14
MWDJAR18	80		2.45	2.59	0.054	0.061	121		0.78	0.68	8.22		1	0			8.23
MWDJAR18	80		2.45	2.66	0.054	0.045	121		0.78	0.66	8.22		1	10			7.85
MWDJAR18	80		2.45	2.54	0.054	0.039	121		0.78	0.60	8.22		1	20			7.61
MWDJAR18	80		2.45	2.32	0.054	0.036	121		0.78	0.65	8.22		1	30			7.45
MWDJAR18	80		2.45	2.35	0.054	0.041	121		0.78	0.54	8.22		1	40			7.35
MWDJAR18	80		2.45	2.22	0.054	0.032	121		0.78	0.67	8.22		1	50			7.23
MWDJAR18	80		2.45	1.95	0.054	0.034	121		0.78	0.82	8.22		1	60			6.97
MWDJAR18	80		2.45	1.97	0.054	0.032	121		0.78	0.76	8.22		1	70			7.00
MWDJAR18	80		2.45	1.77	0.054	0.031	121		0.78	0.78	8.22		1	80			6.90
MWDJAR18	80		2.45	1.82	0.054	0.034	121		0.78	0.75	8.22		1	90			6.88
MWDJAR18	80		2.45	1.76	0.054	0.035	121		0.78	0.73	8.22		1	100			6.82
MWDJAR18	80		2.45	1.75	0.054	0.037	121		0.78	1.00	8.22		1	110			6.77
MWDJAR19	80		2.70	2.87	0.049	0.048	122		0.57	0.55	8.38		1	0			8.46
MWDJAR19	80		2.70	2.65	0.049	0.031	122		0.57	0.69	8.38		1	10			7.85
MWDJAR19	80		2.70	2.44	0.049	0.027	122		0.57	0.60	8.38		1	20			7.64
MWDJAR19	80		2.70	2.22	0.049	0.025	122		0.57	0.56	8.38		1	30			7.32
MWDJAR19	80		2.70	2.04	0.049	0.023	122		0.57	0.59	8.38		1	40			7.18
MWDJAR19	80		2.70	2.02	0.049	0.021	122		0.57	0.78	8.38		1	50			7.13
MWDJAR19	80		2.70	1.97	0.049	0.021	122		0.57	0.75	8.38		1	60			6.80
MWDJAR19	80		2.70	1.85	0.049	0.018	122		0.57	0.81	8.38		1	70			6.79
MWDJAR19	80		2.70	1.78	0.049	0.018	122		0.57	0.97	8.38		1	80			6.71
MWDJAR19	80		2.70	1.88	0.049	0.015	122		0.57	0.89	8.38		1	90			6.67
MWDJAR19	80		2.70	1.77	0.049	0.015	122		0.57	0.84	8.38		1	100			6.56
MWDJAR19	80		2.70	1.88	0.049	0.016	122		0.57	1.50	8.38		1	110			6.52
MWDJAR2	100		2.53	2.90	0.042	0.045	133		0.85	0.90	8.38		1	0			8.45
MWDJAR2	100		2.53	2.89	0.042	0.036	133		0.85	0.71	8.38		1	10			8.02
MWDJAR2	100		2.53	2.68	0.042	0.030	133		0.85	0.53	8.38		1	20			7.72
MWDJAR2	100		2.53	2.51	0.042	0.027	133		0.85	0.40	8.38		1	30			7.46
MWDJAR2	100		2.53	2.19	0.042	0.029	133		0.85	0.64	8.38		1	40			7.34
MWDJAR2	100		2.53	2.30	0.042	0.028	133		0.85	0.57	8.38		1	50			7.26
MWDJAR2	100		2.53	2.03	0.042	0.017	133		0.85	0.78	8.38		1	60			6.96
MWDJAR2	100		2.53	1.99	0.042	0.018	133		0.85	1.10	8.38		1	70			6.85
MWDJAR2	100		2.53	1.90	0.042	0.018	133		0.85	1.20	8.38		1	80			6.84
MWDJAR2	100		2.53	1.90	0.042	0.020	133		0.85	1.30	8.38		1	90			6.81
MWDJAR20	80		2.79	2.87	0.053	0.055	114		0.54	0.38	8.21		1	0			8.15
MWDJAR20	80		2.79	2.46	0.053	0.040	114		0.54	0.37	8.21		1	10			7.45
MWDJAR20	80		2.79	2.60	0.053	0.044	114		0.54	0.25	8.21		1	20			7.58
MWDJAR20	80		2.79	2.39	0.053	0.038	114		0.54	0.24	8.21		1	30			7.42
MWDJAR20	80		2.79	2.28	0.053	0.035	114		0.54	0.24	8.21		1	40			7.30
MWDJAR20	80		2.79	2.20	0.053	0.036	114		0.54	0.20	8.21		1	50			7.21
MWDJAR20	80		2.79	2.13	0.053	0.036	114		0.54	0.20	8.21		1	60			7.19
MWDJAR20	80		2.79	2.03	0.053	0.032	114		0.54	0.23	8.21		1	70			7.10
MWDJAR20	80		2.79	1.97	0.053	0.034	114		0.54	0.26	8.21		1	80			7.01
MWDJAR20	80		2.79	1.95	0.053	0.033	114		0.54	0.27	8.21		1	90			6.97
MWDJAR20	80		2.79	1.83	0.053	0.032	114		0.54	0.27	8.21		1	100			6.82
MWDJAR20	80		2.79	1.79	0.053	0.031	114		0.54	0.63	8.21		1	110			6.80
MWDJAR20	80		2.79	1.74	0.053	0.031	114		0.54	0.39	8.21		1	120			6.74
MWDJAR20	80		2.79	1.70	0.053	0.027	114		0.54	0.43	8.21		1	130			6.62
MWDJAR20	80		2.79	1.62	0.053	0.032	114		0.54	0.53	8.21		1	140			6.48
MWDJAR20	80		2.79	1.61	0.053	0.030	114		0.54	0.58	8.21		1	150			6.53
MWDJAR20	80		2.79	1.61	0.053	0.030	114		0.54	0.53	8.21		1	160			6.42
MWDJAR20	80		2.79	1.63	0.053	0.048	114		0.54	0.60	8.21		1	170			6.33
MWDJAR20	80		2.79	1.47	0.053	0.032	114		0.54	1.20	8.21		1	180			6.19
MWDJAR20	80		2.79	1.55	0.053	0.032	114		0.54	1.40	8.21		1	190			6.10
MWDJAR20	80		2.79	1.52	0.053	0.027	114		0.54	1.50	8.21		1	200			6.08
MWDJAR21	80		2.43	2.42	0.036	0.038	121		0.83	0.73	8.22		1	0			8.23
MWDJAR21	80		2.43	2.42	0.036	0.028	121		0.83	0.69	8.22		1	10			7.94
MWDJAR21	80		2.43	2.29	0.036	0.025	121		0.83	0.52	8.22		1	20			7.60
MWDJAR21	80		2.43	2.09	0.036	0.023	121		0.83	0.32	8.22		1	30			7.47
MWDJAR21	80		2.43	2.04	0.036	0.021	121		0.83	0.46	8.22		1	40			7.35
MWDJAR21	80		2.43	1.97	0.036	0.019	121		0.83	0.57	8.22		1	50			7.28
MWDJAR21	80		2.43	1.80	0.036	0.017	121		0.83	0.51	8.22		1	60			7.30
MWDJAR21	80		2.43	1.77	0.036	0.017	121		0.83	0.57	8.22		1	70			7.28
MWDJAR21	80		2.43	1.73	0.036	0.015	121		0.83	0.67	8.22		1	80			7.13
MWDJAR21	80		2.43	1.72	0.036	0.014	121		0.83	0.71	8.22		1	90			7.06
MWDJAR21	80		2.43	1.70	0.036	0.014	121		0.83	0.72	8.22		1	100			6.96
MWDJAR21	80		2.43	1.69	0.036	0.013	121		0.83	0.98	8.22		1	110			6.95
MWDJAR22	80		2.41	2.53	0.038	0.038	121		0.78	0.71	8.15		1	0			8.25
MWDJAR22	80		2.41	2.31	0.038	0.029	121		0.78	0.50	8.15		1	10			7.92
MWDJAR22	80		2.41	2.23	0.038	0.027	121		0.78	0.68	8.15		1	20			7.71
MWDJAR22	80		2.41	2.04	0.038	0.021	121		0.78	0.55	8.15		1	30			7.52
MWDJAR22	80		2.41	1.96	0.038	0.019	121		0.78	0.50	8.15		1	40			7.43
MWDJAR22	80		2.41	1.90	0.038	0.018	121		0.78	0.38	8.15		1	50			7.30
MWDJAR22	80		2.41	1.81	0.038	0.018	121		0.78	0.73	8.15		1	60			7.03
MWDJAR22	80		2.41	1.74	0.038	0.017	121		0.78	0.85	8.15		1	70			6.90
MWDJAR22	80		2.41	1.68	0.038	0.016	121		0.78	0.80	8.15		1	80			6.83
MWDJAR22	80		2.41	1.64	0.038	0.016	121		0.78	0.76	8.15		1	90			6.76
MWDJAR22	80		2.41	1.58	0.038	0.015	121		0.78	0.81	8.15		1	100			6.72
MWDJAR22	80		2.41	1.56	0.038	0.015	121		0.78	0.93	8.15		1	110			6.70
MWDJAR22	80		2.41	1.42	0.038	0.015	121		0.78	0.95	8.15		1	120			6.55
MWDJAR22	80		2.41	1.33	0.038	0.016	121		0.78	0.95	8.15		1	130			6.50
MWDJAR23	80		2.51	2.56	0.050	0.055	121		0.43	0.45	8.32		1	0			8.33
MWDJAR23	80		2.51	2.43	0.050	0.042	121		0.43	0.58	8.32		1	10			7.92
MWDJAR23	80		2.51	2.25	0.050	0.035	121		0.43	0.44	8.32		1	20			7.65
MWDJAR23	80		2.51	2.12	0.050	0.030	121		0.43	0.50	8.32		1	30			7.49

Study ID	Water		TOC		UV-254		Alkalinity		Turbidity		pH		Coagulation Conditions				
	% CRW	% SPW	(mg/L)		(1/cm)		(mg/L as CaCO3)		(NTU)		()		Coagulant	Dose	Acid	Base	Coag.
			Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	ID		adjusted?	adjusted?	pH
													(see above)		(Y/N)	(Y/N)	()
															blank=N	blank=N	
MWDJAR23	80		2.51	2.00	0.050	0.028	121		0.43	0.36	8.32		1	40			7.39
MWDJAR23	80		2.51	1.92	0.050	0.024	121		0.43	0.40	8.32		1	50			7.28
MWDJAR23	80		2.51	1.79	0.050	0.023	121		0.43	0.42	8.32		1	60			7.21
MWDJAR23	80		2.51	1.75	0.050	0.018	121		0.43	0.45	8.32		1	70			7.16
MWDJAR23	80		2.51	1.62	0.050	0.022	121		0.43	0.48	8.32		1	80			7.07
MWDJAR23	80		2.51	1.56	0.050	0.019	121		0.43	0.55	8.32		1	90			7.00
MWDJAR23	80		2.51	1.56	0.050	0.022	121		0.43	0.58	8.32		1	100			6.95
MWDJAR24	80		2.57	2.45	0.045	0.046	113		0.65	0.59	8.11		1	0			8.20
MWDJAR24	80		2.57	2.49	0.045	0.035	113		0.65	0.32	8.11		1	10			7.95
MWDJAR24	80		2.57	2.32	0.045	0.031	113		0.65	0.29	8.11		1	20			7.80
MWDJAR24	80		2.57	2.09	0.045	0.027	113		0.65	0.28	8.11		1	30			7.62
MWDJAR24	80		2.57	2.05	0.045	0.027	113		0.65	0.28	8.11		1	40			7.50
MWDJAR24	80		2.57	1.90	0.045	0.026	113		0.65	0.27	8.11		1	50			7.39
MWDJAR24	80		2.57	1.90	0.045	0.025	113		0.65	0.27	8.11		1	60			7.19
MWDJAR24	80		2.57	2.03	0.045	0.023	113		0.65	0.27	8.11		1	70			7.11
MWDJAR24	80		2.57	1.92	0.045	0.021	113		0.65	0.28	8.11		1	80			7.03
MWDJAR24	80		2.57	1.80	0.045	0.021	113		0.65	0.40	8.11		1	90			6.93
MWDJAR24	80		2.57	1.69	0.045	0.021	113		0.65	0.44	8.11		1	100			6.90
MWDJAR24	80		2.57	1.61	0.045	0.020	113		0.65	0.45	8.11		1	110			6.86
MWDJAR24	80		2.57	1.61	0.045	0.020	113		0.65	0.54	8.11		1	120			6.78
MWDJAR24	80		2.57	1.64	0.045	0.020	113		0.65	0.62	8.11		1	130			6.67
MWDJAR24	80		2.57	1.55	0.045	0.019	113		0.65	0.80	8.11		1	140			6.58
MWDJAR24	80		2.57	1.69	0.045	0.018	113		0.65	1.20	8.11		1	150			6.53
MWDJAR24	80		2.57	1.57	0.045	0.018	113		0.65	1.20	8.11		1	160			6.45
MWDJAR24	80		2.57	1.44	0.045	0.017	113		0.65	0.89	8.11		1	170			6.37
MWDJAR24	80		2.57	1.46	0.045	0.017	113		0.65	1.53	8.11		1	180			6.30
MWDJAR24	80		2.57	1.36	0.045	0.016	113		0.65	0.76	8.11		1	190			6.22
MWDJAR24	80		2.57	1.35	0.045	0.015	113		0.65	0.77	8.11		1	200			6.13
MWDJAR24	80		2.57	1.40	0.045	0.015	113		0.65	0.75	8.11		1	210			6.04
MWDJAR24	80		2.57	1.29	0.045	0.015	113		0.65	0.95	8.11		1	220			5.91
MWDJAR25	70		2.67	2.67	0.065		109		0.84	0.75	7.84		1	0			7.92
MWDJAR25	70		2.67	2.59	0.065	0.054	109		0.84	0.65	7.84		1	10			7.64
MWDJAR25	70		2.67	2.49	0.065	0.049	109		0.84	0.65	7.84		1	20			7.41
MWDJAR25	70		2.67	2.20	0.065	0.039	109		0.84	0.43	7.84		1	30			7.13
MWDJAR25	70		2.67	2.10	0.065	0.037	109		0.84	0.50	7.84		1	40			6.98
MWDJAR25	70		2.67	1.97	0.065	0.037	109		0.84	0.76	7.84		1	50			6.85
MWDJAR25	70		2.67	1.92	0.065	0.035	109		0.84	0.77	7.84		1	60			6.72
MWDJAR25	70		2.67	1.82	0.065	0.028	109		0.84	0.90	7.84		1	70			6.58
MWDJAR25	70		2.67	1.82	0.065	0.026	109		0.84	0.85	7.84		1	80			6.50
MWDJAR25	70		2.67	1.66	0.065	0.026	109		0.84	0.87	7.84		1	90			6.42
MWDJAR25	70		2.67	1.68	0.065	0.024	109		0.84	0.95	7.84		1	100			6.22
MWDJAR26	70		2.50	2.56	0.055	0.058	115		0.68	0.82	8.22		1	0			8.22
MWDJAR26	70		2.50	2.53	0.055	0.046	115		0.68	0.76	8.22		1	10			7.79
MWDJAR26	70		2.50	2.39	0.055	0.041	115		0.68	0.78	8.22		1	20			7.57
MWDJAR26	70		2.50	2.29	0.055	0.038	115		0.68	0.75	8.22		1	30			7.43
MWDJAR26	70		2.50	2.01	0.055	0.035	115		0.68	0.73	8.22		1	40			7.28
MWDJAR26	70		2.50	2.02	0.055	0.035	115		0.68	1.00	8.22		1	50			7.18
MWDJAR26	70		2.50	1.96	0.055	0.033	115		0.68	0.67	8.22		1	60			6.97
MWDJAR26	70		2.50	1.75	0.055	0.034	115		0.68	0.70	8.22		1	70			7.00
MWDJAR26	70		2.50	1.75	0.055	0.036	115		0.68	0.70	8.22		1	80			6.81
MWDJAR26	70		2.50	1.71	0.055	0.031	115		0.68	0.41	8.22		1	90			6.78
MWDJAR26	70		2.50	1.62	0.055	0.034	115		0.68	0.57	8.22		1	100			6.77
MWDJAR26	70		2.50	1.72	0.055	0.031	115		0.68	0.72	8.22		1	110			6.56
MWDJAR26	70		2.50	1.63	0.055	0.032	115		0.68	1.20	8.22		1	120			6.46
MWDJAR26	70		2.50	1.56	0.055	0.033	115		0.68	1.40	8.22		1	130			6.39
MWDJAR26	70		2.50	1.53	0.055	0.035	115		0.68	1.70	8.22		1	140			6.33
MWDJAR27	70		3.14	2.94	0.064	0.061	115		0.69	0.62	8.32		1	0			8.29
MWDJAR27	70		3.14	2.38	0.064	0.027	115		0.69	0.48	8.32		1	10			7.24
MWDJAR27	70		3.14	2.62	0.064	0.030	115		0.69	0.43	8.32		1	20			7.33
MWDJAR27	70		3.14	2.48	0.064	0.029	115		0.69	0.41	8.32		1	30			7.25
MWDJAR27	70		3.14	2.44	0.064	0.027	115		0.69	0.52	8.32		1	40			7.05
MWDJAR27	70		3.14	2.14	0.064	0.024	115		0.69	0.55	8.32		1	50			6.99
MWDJAR27	70		3.14	3.87	0.064	0.029	115		0.69	0.61	8.32		1	60			6.78
MWDJAR27	70		3.14	2.81	0.064	0.020	115		0.69	0.71	8.32		1	70			6.67
MWDJAR27	70		3.14	1.93	0.064	0.020	115		0.69	0.62	8.32		1	80			6.63
MWDJAR27	70		3.14	1.83	0.064	0.018	115		0.69	0.74	8.32		1	90			6.56
MWDJAR27	70		3.14	1.72	0.064	0.029	115		0.69	0.84	8.32		1	100			6.42
MWDJAR27	70		3.14	1.96	0.064		115		0.69	1.00	8.32		1	110			6.33
MWDJAR27	70		3.14	1.72	0.064	0.025	115		0.69	1.70	8.32		1	120			6.19
MWDJAR27	70		3.14	1.92	0.064	0.019	115		0.69	2.10	8.32		1	130			6.15
MWDJAR27	70		3.14	1.76	0.064	0.017	115		0.69	1.70	8.32		1	140			6.05
MWDJAR27	70		3.14	1.75	0.064	0.016	115		0.69	3.10	8.32		1	150			5.85
MWDJAR28	70		2.74	2.82	0.058	0.057	111		0.47	0.37	8.12		1	0			8.17
MWDJAR28	70		2.74	2.63	0.058	0.047	111		0.47	0.22	8.12		1	10			7.91
MWDJAR28	70		2.74	2.45	0.058	0.042	111		0.47	0.20	8.12		1	20			7.80
MWDJAR28	70		2.74	2.39	0.058	0.039	111		0.47	0.17	8.12		1	30			7.59
MWDJAR28	70		2.74	2.27	0.058	0.033	111		0.47	0.16	8.12		1	40			7.47
MWDJAR28	70		2.74	2.17	0.058	0.039	111		0.47	0.21	8.12		1	50			7.37
MWDJAR28	70		2.74	2.04	0.058	0.032	111		0.47	0.22	8.12		1	60			7.25
MWDJAR28	70		2.74	2.02	0.058	0.030	111		0.47	0.22	8.12		1	70			7.09
MWDJAR28	70		2.74	1.96	0.058	0.027	111		0.47	0.24	8.12		1	80			7.04
MWDJAR28	70		2.74	1.88	0.058	0.027	111		0.47	0.21	8.12		1	90			6.89
MWDJAR28	70		2.74	1.82	0.058	0.028	111		0.47	0.28	8.12		1	100			6.89
MWDJAR28	70		2.74	1.82	0.058	0.030	111		0.47	0.27	8.12		1	110			6.78
MWDJAR28	70		2.74	1.71	0.058	0.025	111		0.47	0.33	8.12		1	120			6.73
MWDJAR28	70		2.74	1.63	0.058	0.029	111		0.47	0.50	8.12		1	130			6.63
MWDJAR28	70		2.74	1.70	0.058	0.030	111		0.47	0.53	8.12		1	140			6.55
MWDJAR28	70		2.74	1.74	0.058	0.027	111		0.47	0.45	8.12		1	150			6.41
MWDJAR28	70		2.74	1.58	0.058	0.026	111		0.47	0.45	8.12		1	160			6.35
MWDJAR28	70		2.74	1.81	0.058	0.044	111		0.47	0.58	8.12		1	170			6.40
MWDJAR28	70		2.74	1.68	0.058	0.023	111		0.47	0.63	8.12		1	180			6.33
MWDJAR28	70		2.74	1.67	0.058	0.041	111		0.47	0.67	8.12		1	190			6.23

Study ID	Water		TOC		UV-254		Alkalinity		Turbidity		pH		Coagulation Conditions				
	% CRW	% SPW	(mg/L)		(1/cm)		(mg/L as CaCO3)		(NTU)		()		Coagulant	Dose	Acid	Base	Coag.
			Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	ID		adjusted?	adjusted?	pH
													(see above)		(Y/N)	(Y/N)	()
															blank=N	blank=N	
MWDJAR29	70		2.50	2.55	0.040	0.040	115		0.68	0.68	8.20		1	0			8.20
MWDJAR29	70		2.50	2.44	0.040	0.030	115		0.68	0.58	8.20		1	10			7.92
MWDJAR29	70		2.50	2.25	0.040	0.026	115		0.68	0.52	8.20		1	20			7.69
MWDJAR29	70		2.50	2.12	0.040	0.023	115		0.68	0.44	8.20		1	30			7.51
MWDJAR29	70		2.50	1.97	0.040	0.020	115		0.68	0.54	8.20		1	40			7.48
MWDJAR29	70		2.50	1.91	0.040	0.020	115		0.68	0.72	8.20		1	50			7.39
MWDJAR29	70		2.50	1.80	0.040	0.019	115		0.68	0.77	8.20		1	60			7.06
MWDJAR29	70		2.50	1.76	0.040	0.018	115		0.68	0.86	8.20		1	70			6.99
MWDJAR29	70		2.50	1.76	0.040	0.018	115		0.68	0.61	8.20		1	80			6.93
MWDJAR29	70		2.50	1.67	0.040	0.017	115		0.68	0.50	8.20		1	90			6.90
MWDJAR29	70		2.50	1.62	0.040	0.016	115		0.68	0.60	8.20		1	100			6.87
MWDJAR29	70		2.50	1.60	0.040	0.015	115		0.68	0.78	8.20		1	110			6.80
MWDJAR29	70		2.50	1.49	0.040	0.015	115		0.68	1.00	8.20		1	120			6.72
MWDJAR29	70		2.50	1.47	0.040	0.017	115		0.68	1.10	8.20		1	130			6.63
MWDJAR29	70		2.50	1.47	0.040	0.016	115		0.68	1.00	8.20		1	140			6.58
MWDJAR29	70		2.50	1.41	0.040	0.018	115		0.68	1.10	8.20		1	150			6.40
MWDJAR29	70		2.50	1.39	0.040	0.014	115		0.68	1.20	8.20		1	160			6.33
MWDJAR29	70		2.50	1.37	0.040	0.014	115		0.68	1.20	8.20		1	170			6.27
MWDJAR3	100		2.50	2.55	0.040	0.037	134		0.42	0.35	8.41		1	0			8.40
MWDJAR3	100		2.50	2.30	0.040	0.029	134		0.42	0.49	8.41		1	10			7.84
MWDJAR3	100		2.50	2.10	0.040	0.029	134		0.42	0.49	8.41		1	20			7.63
MWDJAR3	100		2.50	2.00	0.040	0.025	134		0.42	0.41	8.41		1	30			7.39
MWDJAR3	100		2.50	1.94	0.040	0.023	134		0.42	0.60	8.41		1	40			7.32
MWDJAR3	100		2.50	1.85	0.040	0.022	134		0.42	0.61	8.41		1	50			7.13
MWDJAR3	100		2.50	1.78	0.040	0.022	134		0.42	0.78	8.41		1	60			6.93
MWDJAR3	100		2.50	1.65	0.040	0.019	134		0.42	0.86	8.41		1	70			6.90
MWDJAR3	100		2.50	1.60	0.040	0.020	134		0.42	1.10	8.41		1	80			6.84
MWDJAR30	70		2.44	2.51	0.042	0.042	116		0.8	0.58	8.14		1	0			8.12
MWDJAR30	70		2.44	2.36	0.042	0.032	116		0.8	0.61	8.14		1	10			7.81
MWDJAR30	70		2.44	2.20	0.042	0.027	116		0.8	0.50	8.14		1	20			7.53
MWDJAR30	70		2.44	2.04	0.042	0.024	116		0.8	0.50	8.14		1	30			7.36
MWDJAR30	70		2.44	1.96	0.042	0.022	116		0.8	0.70	8.14		1	40			7.29
MWDJAR30	70		2.44	1.83	0.042	0.021	116		0.8	0.52	8.14		1	50			7.23
MWDJAR30	70		2.44	1.92	0.042	0.019	116		0.8	0.58	8.14		1	60			7.00
MWDJAR30	70		2.44	1.86	0.042	0.019	116		0.8	0.64	8.14		1	70			6.86
MWDJAR30	70		2.44	1.88	0.042	0.017	116		0.8	0.72	8.14		1	80			6.82
MWDJAR30	70		2.44	1.84	0.042	0.016	116		0.8	0.84	8.14		1	90			6.79
MWDJAR30	70		2.44	1.83	0.042	0.015	116		0.8	1.10	8.14		1	100			6.74
MWDJAR30	70		2.44	1.79	0.042	0.015	116		0.8	0.95	8.14		1	110			6.70
MWDJAR30	70		2.44	1.27	0.042	0.019	116		0.8	0.75	8.14		1	120			6.51
MWDJAR30	70		2.44	1.26	0.042	0.018	116		0.8	1.10	8.14		1	130			6.43
MWDJAR30	70		2.44	1.24	0.042	0.017	116		0.8	0.87	8.14		1	140			6.36
MWDJAR30	70		2.44	1.24	0.042	0.016	116		0.8	1.30	8.14		1	150			6.31
MWDJAR30	70		2.44	1.13	0.042	0.015	116		0.8	1.20	8.14		1	160			6.27
MWDJAR31	70		2.60	2.56	0.053	0.053	114		0.45	0.40	8.29		1	0			8.30
MWDJAR31	70		2.60	2.44	0.053	0.052	114		0.45	0.55	8.29		1	10			7.91
MWDJAR31	70		2.60	2.22	0.053	0.036	114		0.45	0.50	8.29		1	20			7.66
MWDJAR31	70		2.60	2.10	0.053	0.033	114		0.45	0.35	8.29		1	30			7.52
MWDJAR31	70		2.60	2.00	0.053	0.031	114		0.45	0.33	8.29		1	40			7.32
MWDJAR31	70		2.60	1.94	0.053	0.029	114		0.45	0.53	8.29		1	50			7.27
MWDJAR31	70		2.60	1.87	0.053	0.028	114		0.45	0.42	8.29		1	60			7.20
MWDJAR31	70		2.60	1.81	0.053	0.026	114		0.45	0.48	8.29		1	70			7.08
MWDJAR31	70		2.60	1.72	0.053	0.024	114		0.45	0.48	8.29		1	80			7.00
MWDJAR31	70		2.60	1.62	0.053	0.023	114		0.45	0.48	8.29		1	90			6.96
MWDJAR31	70		2.60	1.62	0.053	0.023	114		0.45	0.52	8.29		1	100			6.86
MWDJAR31	70		2.60	1.58	0.053	0.021	114		0.45	0.50	8.29		1	110			6.72
MWDJAR31	70		2.60	1.52	0.053	0.021	114		0.45	0.67	8.29		1	120			6.68
MWDJAR31	70		2.60	1.47	0.053	0.020	114		0.45	0.63	8.29		1	130			6.59
MWDJAR31	70		2.60	1.50	0.053	0.020	114		0.45	0.73	8.29		1	140			6.52
MWDJAR31	70		2.60	1.46	0.053	0.019	114		0.45	0.77	8.29		1	150			6.46
MWDJAR31	70		2.60	1.40	0.053	0.018	114		0.45	0.71	8.29		1	160			6.39
MWDJAR31	70		2.60	1.26	0.053	0.018	114		0.45	1.00	8.29		1	170			6.55
MWDJAR31	70		2.60	1.30	0.053	0.017	114		0.45	1.10	8.29		1	180			6.43
MWDJAR31	70		2.60	1.17	0.053	0.017	114		0.45	1.10	8.29		1	190			6.34
MWDJAR31	70		2.60	1.12	0.053	0.016	114		0.45	1.40	8.29		1	200			6.23
MWDJAR32	70		2.49	2.51	0.048	0.047	106		0.52	0.44	8.06		1	0			8.07
MWDJAR32	70		2.49	2.36	0.048	0.047	106		0.52	0.37	8.06		1	10			7.90
MWDJAR32	70		2.49	2.18	0.048	0.040	106		0.52	0.26	8.06		1	20			7.73
MWDJAR32	70		2.49	1.96	0.048	0.042	106		0.52	0.32	8.06		1	30			7.51
MWDJAR32	70		2.49	2.09	0.048	0.035	106		0.52	0.29	8.06		1	40			7.48
MWDJAR32	70		2.49	2.04	0.048	0.030	106		0.52	0.29	8.06		1	50			7.41
MWDJAR32	70		2.49	1.81	0.048	0.027	106		0.52	0.25	8.06		1	60			7.27
MWDJAR32	70		2.49	1.80	0.048	0.022	106		0.52	0.30	8.06		1	70			7.14
MWDJAR32	70		2.49	1.74	0.048	0.022	106		0.52	0.33	8.06		1	80			7.04
MWDJAR32	70		2.49	1.73	0.048	0.022	106		0.52	0.30	8.06		1	90			6.97
MWDJAR32	70		2.49	1.67	0.048	0.023	106		0.52	0.37	8.06		1	100			6.86
MWDJAR32	70		2.49	1.67	0.048	0.023	106		0.52	0.42	8.06		1	110			6.83
MWDJAR32	70		2.49	1.60	0.048	0.021	106		0.52	0.39	8.06		1	120			6.80
MWDJAR32	70		2.49	1.59	0.048	0.019	106		0.52	0.49	8.06		1	130			6.75
MWDJAR32	70		2.49	1.62	0.048	0.018	106		0.52	0.53	8.06		1	140			6.66
MWDJAR32	70		2.49	1.52	0.048	0.018	106		0.52	0.56	8.06		1	150			6.65
MWDJAR32	70		2.49	1.55	0.048	0.018	106		0.52	0.70	8.06		1	160			6.51
MWDJAR32	70		2.49	1.56	0.048	0.017	106		0.52	0.61	8.06		1	170			6.41
MWDJAR32	70		2.49	1.41	0.048	0.017	106		0.52	0.65	8.06		1	180			6.34
MWDJAR32	70		2.49	1.39	0.048	0.017	106		0.52	0.78	8.06		1	190			6.13
MWDJAR32	70		2.49	1.50	0.048	0.015	106		0.52	0.85	8.06		1	200			6.06
MWDJAR32	70		2.49	1.37	0.048	0.015	106		0.52	0.85	8.06		1	210			5.90
MWDJAR32	70		2.49	1.33	0.048	0.015	106		0.52	1.10	8.06		1	220			5.86
MWDJAR33	60		2.72	2.69	0.074		104		1.70		8.03		1	0			7.91
MWDJAR33	60		2.72	2.62	0.074	0.062	104		1.70	0.53	8.03		1	10			7.59
MWDJAR33	60		2.72	2.50	0.074	0.055	104		1.70	0.66	8.03		1	20			7.38
MWDJAR33	60		2.72	2.40	0.074	0.048	104		1.70	0.64	8.03		1	30			7.17

Study ID	Water		TOC		UV-254		Alkalinity		Turbidity		pH		Coagulation Conditions				
	% CRW	% SPW	(mg/L)		(1/cm)		(mg/L as CaCO3)		(NTU)		()		Coagulant	Dose	Acid	Base	Coag.
			Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	ID		adjusted?	adjusted?	pH
													(see above)		(Y/N)	(Y/N)	()
															blank=N	blank=N	
MWDJAR33	60		2.72	2.15	0.074	0.043	104		1.70	0.75	8.03		1	40			6.98
MWDJAR33	60		2.72	2.09	0.074	0.042	104		1.70	0.84	8.03		1	50			6.92
MWDJAR33	60		2.72	2.04	0.074	0.041	104		1.70	0.86	8.03		1	60			6.77
MWDJAR33	60		2.72	1.92	0.074	0.039	104		1.70	0.81	8.03		1	70			6.49
MWDJAR33	60		2.72	1.86	0.074	0.038	104		1.70	1.10	8.03		1	80			6.33
MWDJAR33	60		2.72	1.75	0.074	0.035	104		1.70	0.97	8.03		1	90			6.26
MWDJAR33	60		2.72	1.67	0.074	0.037	104		1.70	2.00	8.03		1	100			6.11
MWDJAR34	60		2.51	2.67	0.048	0.043	109		0.77	0.67	8.27		1	0			8.27
MWDJAR34	60		2.51	2.57	0.048	0.035	109		0.77	0.70	8.27		1	10			7.79
MWDJAR34	60		2.51	2.46	0.048	0.031	109		0.77	0.70	8.27		1	20			7.57
MWDJAR34	60		2.51	2.32	0.048	0.025	109		0.77	0.41	8.27		1	30			7.43
MWDJAR34	60		2.51	2.24	0.048	0.025	109		0.77	0.57	8.27		1	40			7.28
MWDJAR34	60		2.51	2.22	0.048	0.024	109		0.77	0.72	8.27		1	50			7.18
MWDJAR34	60		2.51	1.91	0.048	0.021	109		0.77	0.57	8.27		1	60			7.09
MWDJAR34	60		2.51	1.99	0.048	0.020	109		0.77	0.81	8.27		1	70			6.98
MWDJAR34	60		2.51	1.82	0.048	0.019	109		0.77	0.66	8.27		1	80			6.91
MWDJAR34	60		2.51	1.76	0.048	0.027	109		0.77	0.73	8.27		1	90			6.81
MWDJAR34	60		2.51	1.69	0.048	0.023	109		0.77	0.78	8.27		1	100			6.76
MWDJAR34	60		2.51	1.64	0.048	0.022	109		0.77	0.88	8.27		1	110			6.68
MWDJAR34	60		2.51	1.48	0.048	0.035	109		0.77	1.40	8.27		1	120			6.45
MWDJAR34	60		2.51	1.47	0.048	0.036	109		0.77	1.50	8.27		1	130			6.41
MWDJAR35	60		3.44	3.13	0.081	0.077	111		0.74	0.65	8.36		1	0			8.34
MWDJAR35	60		3.44	3.27	0.081	0.054	111		0.74	0.58	8.36		1	10			7.86
MWDJAR35	60		3.44	2.92	0.081	0.044	111		0.74	0.50	8.36		1	20			7.57
MWDJAR35	60		3.44	2.66	0.081	0.038	111		0.74	0.56	8.36		1	30			7.39
MWDJAR35	60		3.44	2.49	0.081	0.036	111		0.74	0.47	8.36		1	40			7.25
MWDJAR35	60		3.44	2.33	0.081	0.031	111		0.74	0.43	8.36		1	50			7.10
MWDJAR35	60		3.44	2.27	0.081	0.043	111		0.74	0.67	8.36		1	60			6.83
MWDJAR35	60		3.44	2.15	0.081	0.034	111		0.74	0.72	8.36		1	70			6.78
MWDJAR35	60		3.44	2.02	0.081	0.028	111		0.74	0.84	8.36		1	80			6.69
MWDJAR35	60		3.44	2.08	0.081	0.028	111		0.74	0.70	8.36		1	90			6.61
MWDJAR35	60		3.44	1.88	0.081	0.026	111		0.74	0.58	8.36		1	100			6.54
MWDJAR35	60		3.44	1.81	0.081	0.028	111		0.74	0.68	8.36		1	110			6.38
MWDJAR35	60		3.44	1.77	0.081	0.028	111		0.74	1.10	8.36		1	120			6.17
MWDJAR35	60		3.44	1.64	0.081	0.027	111		0.74	1.10	8.36		1	130			6.06
MWDJAR35	60		3.44	1.65	0.081	0.031	111		0.74	1.30	8.36		1	140			6.00
MWDJAR35	60		3.44	1.64	0.081	0.028	111		0.74	1.50	8.36		1	150			5.93
MWDJAR36	60		3.22	3.20	0.064	0.063	107		0.43	0.40	8.10		1	0			8.13
MWDJAR36	60		3.22	2.98	0.064	0.051	107		0.43	0.27	8.10		1	10			7.78
MWDJAR36	60		3.22	2.80	0.064	0.047	107		0.43	0.30	8.10		1	20			7.58
MWDJAR36	60		3.22	2.69	0.064	0.044	107		0.43	0.27	8.10		1	30			7.43
MWDJAR36	60		3.22	2.52	0.064	0.040	107		0.43	0.18	8.10		1	40			7.31
MWDJAR36	60		3.22	2.38	0.064	0.038	107		0.43	0.32	8.10		1	50			7.19
MWDJAR36	60		3.22	2.34	0.064	0.037	107		0.43	0.26	8.10		1	60			7.46
MWDJAR36	60		3.22	2.24	0.064	0.035	107		0.43	0.25	8.10		1	70			7.25
MWDJAR36	60		3.22	2.17	0.064	0.034	107		0.43	0.27	8.10		1	80			7.06
MWDJAR36	60		3.22	2.07	0.064	0.033	107		0.43	0.26	8.10		1	90			6.95
MWDJAR36	60		3.22	2.02	0.064	0.030	107		0.43	0.27	8.10		1	100			6.86
MWDJAR36	60		3.22	1.98	0.064	0.037	107		0.43	0.45	8.10		1	110			6.78
MWDJAR36	60		3.22	1.75	0.064	0.026	107		0.43	0.36	8.10		1	120			6.77
MWDJAR36	60		3.22	1.74	0.064	0.026	107		0.43	0.36	8.10		1	130			6.66
MWDJAR36	60		3.22	1.72	0.064	0.027	107		0.43	0.38	8.10		1	140			6.58
MWDJAR36	60		3.22	1.75	0.064	0.026	107		0.43	0.42	8.10		1	150			6.49
MWDJAR36	60		3.22	1.81	0.064	0.025	107		0.43	0.35	8.10		1	160			6.51
MWDJAR36	60		3.22	1.70	0.064	0.039	107		0.43	0.95	8.10		1	170			6.34
MWDJAR36	60		3.22	1.71	0.064	0.037	107		0.43	0.87	8.10		1	180			6.21
MWDJAR36	60		3.22	1.64	0.064	0.050	107		0.43	1.13	8.10		1	190			6.13
MWDJAR37	60		2.56	2.68	0.039	0.038	109		0.88	0.70	8.15		1	0			8.35
MWDJAR37	60		2.56	2.49	0.039	0.036	109		0.88	0.56	8.15		1	10			7.95
MWDJAR37	60		2.56	2.35	0.039	0.030	109		0.88	0.52	8.15		1	20			7.78
MWDJAR37	60		2.56	2.23	0.039	0.026	109		0.88	0.30	8.15		1	30			7.57
MWDJAR37	60		2.56	2.22	0.039	0.024	109		0.88	0.58	8.15		1	40			7.40
MWDJAR37	60		2.56	2.07	0.039	0.023	109		0.88	0.54	8.15		1	50			7.29
MWDJAR37	60		2.56	1.84	0.039	0.021	109		0.88	0.56	8.15		1	60			7.25
MWDJAR37	60		2.56	1.81	0.039	0.019	109		0.88	0.65	8.15		1	70			7.12
MWDJAR37	60		2.56	1.76	0.039	0.017	109		0.88	0.65	8.15		1	80			7.01
MWDJAR37	60		2.56	1.63	0.039	0.015	109		0.88	0.87	8.15		1	90			6.96
MWDJAR37	60		2.56	1.62	0.039	0.016	109		0.88	0.86	8.15		1	100			6.88
MWDJAR37	60		2.56	1.58	0.039	0.015	109		0.88	0.86	8.15		1	110			6.81
MWDJAR37	60		2.56	1.42	0.039	0.018	109		0.88	0.97	8.15		1	120			6.76
MWDJAR37	60		2.56	1.42	0.039	0.017	109		0.88	0.95	8.15		1	130			6.56
MWDJAR37	60		2.56	1.38	0.039	0.015	109		0.88	0.87	8.15		1	140			6.39
MWDJAR37	60		2.56	1.37	0.039	0.015	109		0.88	1.00	8.15		1	150			6.36
MWDJAR37	60		2.56	1.39	0.039	0.015	109		0.88	1.00	8.15		1	160			6.28
MWDJAR37	60		2.56	1.33	0.039	0.014	109		0.88	1.20	8.15		1	170			6.23
MWDJAR38	60		2.49	2.47	0.049	0.049	110		0.84	0.76	8.13		1	0			8.14
MWDJAR38	60		2.49	2.35	0.049	0.035	110		0.84	0.53	8.13		1	10			7.74
MWDJAR38	60		2.49	2.12	0.049	0.027	110		0.84	0.39	8.13		1	20			7.44
MWDJAR38	60		2.49	1.92	0.049	0.023	110		0.84	0.33	8.13		1	30			7.29
MWDJAR38	60		2.49	1.86	0.049	0.020	110		0.84	0.45	8.13		1	40			7.18
MWDJAR38	60		2.49	1.80	0.049	0.020	110		0.84	0.48	8.13		1	50			7.11
MWDJAR38	60		2.49	1.56	0.049	0.020	110		0.84	0.60	8.13		1	60			6.95
MWDJAR38	60		2.49	1.62	0.049	0.018	110		0.84	0.62	8.13		1	70			6.87
MWDJAR38	60		2.49	1.51	0.049	0.017	110		0.84	0.49	8.13		1	80			6.85
MWDJAR38	60		2.49	1.47	0.049	0.017	110		0.84	0.54	8.13		1	90			6.79
MWDJAR38	60		2.49	1.38	0.049	0.014	110		0.84	0.84	8.13		1	100			6.71
MWDJAR38	60		2.49	1.39	0.049	0.014	110		0.84	0.83	8.13		1	110			6.59
MWDJAR38	60		2.49	1.34	0.049	0.020	110		0.84	0.97	8.13		1	120			6.53
MWDJAR38	60		2.49	1.35	0.049	0.021	110		0.84	0.95	8.13		1	130			6.48
MWDJAR38	60		2.49	1.34	0.049	0.020	110		0.84	1.10	8.13		1	140			6.39
MWDJAR38	60		2.49	1.29	0.049	0.019	110		0.84	1.20	8.13		1	150			6.33
MWDJAR38	60		2.49	1.31	0.049	0.018	110		0.84	1.20	8.13		1	160			6.21

Study ID	Water		TOC		UV-254		Alkalinity		Turbidity		pH		Coagulation Conditions				
	% CRW	% SPW	(mg/L)		(1/cm)		(mg/L as CaCO3)		(NTU)		()		Coagulant	Dose	Acid	Base	Coag.
			Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	ID		adjusted?	adjusted?	pH
													(see above)		(Y/N)	(Y/N)	()
															blank=N	blank=N	
MWDJAR39	60		2.68	2.69	0.059	0.057	109		0.48	0.45	8.26		1	0			8.22
MWDJAR39	60		2.68	2.48	0.059	0.042	109		0.48	0.51	8.26		1	10			7.87
MWDJAR39	60		2.68	2.31	0.059	0.039	109		0.48	0.37	8.26		1	20			7.65
MWDJAR39	60		2.68	2.15	0.059	0.035	109		0.48	0.32	8.26		1	30			7.52
MWDJAR39	60		2.68	1.98	0.059	0.031	109		0.48	0.38	8.26		1	40			7.36
MWDJAR39	60		2.68	1.87	0.059	0.030	109		0.48	0.37	8.26		1	50			7.29
MWDJAR39	60		2.68	1.80	0.059	0.026	109		0.48	0.42	8.26		1	60			7.12
MWDJAR39	60		2.68	1.74	0.059	0.026	109		0.48	0.54	8.26		1	70			7.02
MWDJAR39	60		2.68	1.66	0.059	0.025	109		0.48	0.48	8.26		1	80			6.95
MWDJAR39	60		2.68	1.61	0.059	0.023	109		0.48	0.58	8.26		1	90			6.88
MWDJAR39	60		2.68	1.60	0.059	0.022	109		0.48	0.68	8.26		1	100			6.79
MWDJAR39	60		2.68	1.60	0.059	0.025	109		0.48	0.77	8.26		1	110			6.83
MWDJAR39	60		2.68	1.50	0.059	0.023	109		0.48	0.76	8.26		1	120			6.75
MWDJAR39	60		2.68	1.57	0.059	0.023	109		0.48	1.00	8.26		1	130			6.62
MWDJAR39	60		2.68	1.43	0.059	0.021	109		0.48	0.80	8.26		1	140			6.42
MWDJAR39	60		2.68	1.41	0.059	0.021	109		0.48	0.92	8.26		1	150			6.38
MWDJAR39	60		2.68	1.34	0.059	0.021	109		0.48	0.92	8.26		1	160			6.27
MWDJAR4	100		2.55	2.67	0.043	0.040	123		0.85	0.20	8.23		1	0			8.08
MWDJAR4	100		2.55	2.68	0.043	0.038	123		0.85	0.40	8.23		1	10			7.85
MWDJAR4	100		2.55	2.54	0.043	0.034	123		0.85	0.30	8.23		1	20			7.60
MWDJAR4	100		2.55	2.44	0.043	0.031	123		0.85	0.26	8.23		1	30			7.49
MWDJAR4	100		2.55	2.31	0.043	0.029	123		0.85	0.21	8.23		1	40			7.37
MWDJAR4	100		2.55	2.26	0.043	0.029	123		0.85	0.33	8.23		1	50			7.27
MWDJAR4	100		2.55	2.09	0.043	0.027	123		0.85	0.21	8.23		1	60			7.21
MWDJAR4	100		2.55	2.04	0.043	0.030	123		0.85	0.22	8.23		1	70			7.05
MWDJAR4	100		2.55	1.95	0.043	0.026	123		0.85	0.25	8.23		1	80			6.97
MWDJAR4	100		2.55	1.92	0.043	0.027	123		0.85	0.31	8.23		1	90			6.91
MWDJAR4	100		2.55	1.84	0.043	0.025	123		0.85	0.25	8.23		1	100			6.82
MWDJAR4	100		2.55	1.85	0.043	0.027	123		0.85	0.55	8.23		1	110			6.75
MWDJAR40	60		2.57	2.53	0.042	0.046	101		3.10	0.52	8.05		1	0			8.03
MWDJAR40	60		2.57	2.41	0.042	0.042	101		3.10	0.33	8.05		1	10			7.85
MWDJAR40	60		2.57	3.35	0.042	0.035	101		3.10	0.34	8.05		1	20			7.68
MWDJAR40	60		2.57	2.16	0.042	0.032	101		3.10	0.24	8.05		1	30			7.54
MWDJAR40	60		2.57	2.04	0.042	0.030	101		3.10	0.27	8.05		1	40			7.33
MWDJAR40	60		2.57	1.80	0.042	0.028	101		3.10	0.24	8.05		1	50			7.26
MWDJAR40	60		2.57	1.76	0.042	0.026	101		3.10	0.20	8.05		1	60			7.13
MWDJAR40	60		2.57	1.66	0.042	0.024	101		3.10	0.32	8.05		1	70			7.02
MWDJAR40	60		2.57	1.66	0.042	0.022	101		3.10	0.38	8.05		1	80			6.96
MWDJAR40	60		2.57	1.59	0.042	0.021	101		3.10	0.33	8.05		1	90			6.89
MWDJAR40	60		2.57	1.57	0.042	0.021	101		3.10	0.38	8.05		1	100			6.75
MWDJAR40	60		2.57	1.49	0.042	0.022	101		3.10	0.45	8.05		1	110			6.74
MWDJAR40	60		2.57	1.48	0.042	0.021	101		3.10	0.54	8.05		1	120			6.70
MWDJAR40	60		2.57	1.47	0.042	0.020	101		3.10	0.61	8.05		1	130			6.65
MWDJAR40	60		2.57	1.39	0.042	0.019	101		3.10	0.69	8.05		1	140			6.54
MWDJAR40	60		2.57	1.39	0.042	0.019	101		3.10	0.70	8.05		1	150			6.46
MWDJAR40	60		2.57	1.36	0.042	0.018	101		3.10	0.75	8.05		1	160			6.39
MWDJAR40	60		2.57	1.53	0.042	0.017	101		3.10	0.80	8.05		1	170			6.30
MWDJAR40	60		2.57	1.61	0.042	0.017	101		3.10	1.20	8.05		1	180			6.19
MWDJAR40	60		2.57	1.50	0.042	0.016	101		3.10	1.20	8.05		1	190			6.13
MWDJAR41	50		2.64	2.78	0.079		94		0.85		8.13		1	0			7.98
MWDJAR41	50		2.64	2.69	0.079	0.065	94		0.85	0.56	8.13		1	10			7.47
MWDJAR41	50		2.64	2.50	0.079	0.058	94		0.85	0.65	8.13		1	20			7.25
MWDJAR41	50		2.64	2.40	0.079		94		0.85	0.50	8.13		1	30			7.05
MWDJAR41	50		2.64	2.23	0.079	0.040	94		0.85	0.50	8.13		1	40			6.93
MWDJAR41	50		2.64	2.13	0.079	0.041	94		0.85	0.70	8.13		1	50			6.82
MWDJAR41	50		2.64	2.15	0.079	0.040	94		0.85	0.58	8.13		1	60			6.73
MWDJAR41	50		2.64	1.97	0.079	0.031	94		0.85	0.80	8.13		1	70			6.61
MWDJAR41	50		2.64	1.96	0.079	0.031	94		0.85	1.00	8.13		1	80			6.44
MWDJAR41	50		2.64	1.85	0.079	0.030	94		0.85	0.98	8.13		1	90			6.19
MWDJAR42	50		2.37	2.52	0.061	0.054	103		0.75	0.78	8.17		1	0			8.15
MWDJAR42	50		2.37	2.32	0.061	0.034	103		0.75	0.57	8.17		1	10			7.49
MWDJAR42	50		2.37	2.19	0.061	0.031	103		0.75	0.68	8.17		1	20			7.32
MWDJAR42	50		2.37	2.00	0.061	0.027	103		0.75	0.51	8.17		1	30			7.12
MWDJAR42	50		2.37	1.91	0.061	0.025	103		0.75	0.86	8.17		1	40			7.03
MWDJAR42	50		2.37	1.79	0.061	0.028	103		0.75	0.85	8.17		1	50			6.88
MWDJAR42	50		2.37	1.77	0.061	0.024	103		0.75	1.10	8.17		1	60			6.69
MWDJAR42	50		2.37	1.83	0.061	0.028	103		0.75	1.30	8.17		1	70			6.60
MWDJAR42	50		2.37	1.80	0.061	0.028	103		0.75	1.50	8.17		1	80			6.51
MWDJAR42	50		2.37	1.66	0.061	0.024	103		0.75	1.40	8.17		1	90			6.49
MWDJAR42	50		2.37	1.72	0.061	0.026	103		0.75	1.50	8.17		1	100			6.41
MWDJAR42	50		2.37	1.58	0.061	0.028	103		0.75	1.50	8.17		1	110			6.26
MWDJAR43	50		3.18	3.41	0.081	0.079	106		0.87	0.74	8.32		1	0			8.37
MWDJAR43	50		3.18	3.03	0.081	0.058	106		0.87	0.86	8.32		1	10			7.88
MWDJAR43	50		3.18	2.78	0.081	0.046	106		0.87	0.72	8.32		1	20			7.58
MWDJAR43	50		3.18	2.50	0.081	0.039	106		0.87	0.66	8.32		1	30			7.36
MWDJAR43	50		3.18	2.26	0.081	0.036	106		0.87	0.51	8.32		1	40			7.22
MWDJAR43	50		3.18	2.29	0.081	0.036	106		0.87	0.51	8.32		1	50			7.13
MWDJAR43	50		3.18	2.28	0.081	0.038	106		0.87	0.61	8.32		1	60			6.71
MWDJAR43	50		3.18	2.10	0.081	0.036	106		0.87	0.67	8.32		1	70			6.70
MWDJAR43	50		3.18	2.02	0.081	0.032	106		0.87	0.76	8.32		1	80			6.58
MWDJAR43	50		3.18	2.08	0.081	0.034	106		0.87	0.73	8.32		1	90			6.54
MWDJAR43	50		3.18	2.05	0.081	0.032	106		0.87	0.76	8.32		1	100			6.49
MWDJAR43	50		3.18	2.07	0.081	0.030	106		0.87	1.20	8.32		1	110			6.33
MWDJAR43	50		3.18	1.92	0.081	0.030	106		0.87	1.10	8.32		1	120			6.24
MWDJAR43	50		3.18	2.11	0.081	0.027	106		0.87	1.40	8.32		1	130			6.13
MWDJAR43	50		3.18	1.77	0.081	0.026	106		0.87	2.00	8.32		1	140			5.99
MWDJAR43	50		3.18	2.02	0.081	0.025	106		0.87	1.40	8.32		1	150			5.93
MWDJAR44	50		3.11	3.17	0.066	0.070	103		1.30	0.51	7.99		1	0			8.14
MWDJAR44	50		3.11	2.20	0.066	0.049	103		1.30	0.28	7.99		1	10			7.76
MWDJAR44	50		3.11	2.78	0.066	0.045	103		1.30	0.27	7.99		1	20			7.50
MWDJAR44	50		3.11	2.64	0.066	0.041	103		1.30	0.24	7.99		1	30			7.36
MWDJAR44	50		3.11	2.42	0.066	0.036	103		1.30	0.25	7.99		1	40			7.20

Study ID	Water		TOC		UV-254		Alkalinity		Turbidity		pH		Coagulation Conditions				
	% CRW	% SPW	(mg/L)		(1/cm)		(mg/L as CaCO3)		(NTU)		()		Coagulant	Dose	Acid	Base	Coag.
			Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	ID		adjusted?	adjusted?	pH
													(see above)		(Y/N)	(Y/N)	()
															blank=N	blank=N	
MWDJAR44	50		3.11	2.32	0.066	0.035	103		1.30	0.21	7.99		1	50			7.14
MWDJAR44	50		3.11	2.25	0.066	0.032	103		1.30	0.19	7.99		1	60			7.07
MWDJAR44	50		3.11	3.04	0.066	0.033	103		1.30	0.25	7.99		1	70			6.93
MWDJAR44	50		3.11	2.07	0.066	0.033	103		1.30	0.29	7.99		1	80			6.87
MWDJAR44	50		3.11	2.02	0.066	0.030	103		1.30	0.33	7.99		1	90			6.78
MWDJAR44	50		3.11	1.97	0.066	0.028	103		1.30	0.35	7.99		1	100			6.68
MWDJAR44	50		3.11	1.85	0.066	0.027	103		1.30	0.28	7.99		1	110			6.65
MWDJAR44	50		3.11	1.83	0.066	0.030	103		1.30	0.46	7.99		1	120			6.52
MWDJAR44	50		3.11	1.83	0.066	0.030	103		1.30	0.56	7.99		1	130			6.51
MWDJAR44	50		3.11	1.78	0.066	0.028	103		1.30	0.52	7.99		1	140			6.44
MWDJAR44	50		3.11	1.69	0.066	0.028	103		1.30	0.44	7.99		1	150			6.34
MWDJAR44	50		3.11	1.66	0.066	0.030	103		1.30	0.45	7.99		1	160			6.34
MWDJAR45	50		2.46	2.63		0.061	105		0.87	0.78	8.14		1	0			8.27
MWDJAR45	50		2.46	2.30		0.047	105		0.87	0.55	8.14		1	10			7.91
MWDJAR45	50		2.46	2.26		0.042	105		0.87	0.50	8.14		1	20			7.52
MWDJAR45	50		2.46	2.07		0.036	105		0.87	0.52	8.14		1	30			7.55
MWDJAR45	50		2.46	1.96		0.034	105		0.87	0.33	8.14		1	40			7.31
MWDJAR45	50		2.46	1.84		0.032	105		0.87	0.40	8.14		1	50			7.26
MWDJAR45	50		2.46	1.82		0.029	105		0.87	0.52	8.14		1	60			7.16
MWDJAR45	50		2.46	1.72		0.028	105		0.87	0.44	8.14		1	70			7.12
MWDJAR45	50		2.46	1.76		0.027	105		0.87	0.62	8.14		1	80			7.02
MWDJAR45	50		2.46	1.69		0.026	105		0.87	0.64	8.14		1	90			6.80
MWDJAR45	50		2.46	1.59		0.025	105		0.87	0.72	8.14		1	100			6.76
MWDJAR45	50		2.46	1.56		0.024	105		0.87	0.94	8.14		1	110			6.71
MWDJAR45	50		2.46	1.52		0.023	105		0.87	0.65	8.14		1	120			6.62
MWDJAR45	50		2.46	1.46		0.022	105		0.87	0.80	8.14		1	130			6.50
MWDJAR45	50		2.46	1.45		0.021	105		0.87	1.00	8.14		1	140			6.48
MWDJAR45	50		2.46	1.48		0.016	105		0.87	1.10	8.14		1	150			6.52
MWDJAR45	50		2.46	1.38		0.015	105		0.87	1.20	8.14		1	160			6.39
MWDJAR45	50		2.46	1.36		0.014	105		0.87	1.30	8.14		1	170			6.27
MWDJAR45	50		2.46	1.31		0.015	105		0.87	1.50	8.14		1	180			6.18
MWDJAR46	50		2.46	2.56	0.040	0.040	105		0.73	0.60	8.13		1	0			8.20
MWDJAR46	50		2.46	2.54	0.040	0.028	105		0.73	0.70	8.13		1	10			7.86
MWDJAR46	50		2.46	2.43	0.040	0.019	105		0.73	0.44	8.13		1	20			7.63
MWDJAR46	50		2.46	2.13	0.040	0.013	105		0.73	0.29	8.13		1	30			7.45
MWDJAR46	50		2.46	2.05	0.040	0.011	105		0.73	0.52	8.13		1	40			7.31
MWDJAR46	50		2.46	2.00	0.040	0.010	105		0.73	0.67	8.13		1	50			7.19
MWDJAR46	50		2.46	1.86	0.040	0.010	105		0.73	0.66	8.13		1	60			7.17
MWDJAR46	50		2.46	1.73	0.040	0.010	105		0.73	0.71	8.13		1	70			7.04
MWDJAR46	50		2.46	1.75	0.040	0.010	105		0.73	0.83	8.13		1	80			6.93
MWDJAR46	50		2.46	1.62	0.040	0.007	105		0.73	0.75	8.13		1	90			6.84
MWDJAR46	50		2.46	1.59	0.040	0.004	105		0.73	0.95	8.13		1	100			6.75
MWDJAR46	50		2.46	1.59	0.040	0.004	105		0.73	1.50	8.13		1	110			6.66
MWDJAR46	50		2.46	1.26	0.040	0.023	105		0.73	1.00	8.13		1	120			6.50
MWDJAR46	50		2.46	1.32	0.040	0.019	105		0.73	1.10	8.13		1	130			6.46
MWDJAR46	50		2.46	1.18	0.040	0.017	105		0.73	0.25	8.13		1	140			6.31
MWDJAR46	50		2.46	1.17	0.040	0.016	105		0.73	1.10	8.13		1	150			6.27
MWDJAR46	50		2.46	1.15	0.040	0.021	105		0.73	1.30	8.13		1	160			6.15
MWDJAR47	50		2.79	2.79	0.063	0.062	102		0.42	0.40	8.23		1	0			8.27
MWDJAR47	50		2.79	2.70	0.063	0.049	102		0.42	0.50	8.23		1	10			7.85
MWDJAR47	50		2.79	2.39	0.063	0.041	102		0.42	0.48	8.23		1	20			7.56
MWDJAR47	50		2.79	2.20	0.063	0.036	102		0.42	0.39	8.23		1	30			7.38
MWDJAR47	50		2.79	2.15	0.063	0.032	102		0.42	0.42	8.23		1	40			7.23
MWDJAR47	50		2.79	1.94	0.063	0.028	102		0.42	0.45	8.23		1	50			7.18
MWDJAR47	50		2.79	1.84	0.063	0.026	102		0.42	0.50	8.23		1	60			7.13
MWDJAR47	50		2.79	1.76	0.063	0.025	102		0.42	0.50	8.23		1	70			7.03
MWDJAR47	50		2.79	1.69	0.063	0.024	102		0.42	0.43	8.23		1	80			6.92
MWDJAR47	50		2.79	1.60	0.063	0.024	102		0.42	0.54	8.23		1	90			6.87
MWDJAR47	50		2.79	1.58	0.063	0.022	102		0.42	0.58	8.23		1	100			6.77
MWDJAR47	50		2.79	1.61	0.063	0.023	102		0.42	0.68	8.23		1	110			6.61
MWDJAR47	50		2.79	1.53	0.063	0.021	102		0.42	0.84	8.23		1	120			6.46
MWDJAR47	50		2.79	1.50	0.063	0.021	102		0.42	0.82	8.23		1	130			6.38
MWDJAR47	50		2.79	1.49	0.063	0.020	102		0.42	0.86	8.23		1	140			6.34
MWDJAR47	50		2.79	1.44	0.063	0.019	102		0.42	0.90	8.23		1	150			6.20
MWDJAR47	50		2.79	1.45	0.063	0.020	102		0.42	1.30	8.23		1	160			6.11
MWDJAR48		100	3.31	3.31	0.126		73		2.40	1.30	7.91		1	0			7.87
MWDJAR48		100	3.31	3.21	0.126	0.103	73		2.40	0.88	7.91		1	10			7.57
MWDJAR48		100	3.31	3.05	0.126	0.081	73		2.40	0.53	7.91		1	20			7.32
MWDJAR48		100	3.31	2.68	0.126	0.066	73		2.40	0.54	7.91		1	30			7.14
MWDJAR48		100	3.31	2.36	0.126	0.061	73		2.40	0.52	7.91		1	40			6.83
MWDJAR48		100	3.31	2.22	0.126	0.054	73		2.40	0.45	7.91		1	50			6.79
MWDJAR48		100	3.31	2.12	0.126	0.049	73		2.40	0.50	7.91		1	60			6.64
MWDJAR48		100	3.31	1.89	0.126	0.049	73		2.40	0.95	7.91		1	70			6.15
MWDJAR48		100	3.31	1.83	0.126	0.050	73		2.40	0.83	7.91		1	80			6.09
MWDJAR48		100	3.31	1.78	0.126	0.049	73		2.40	1.10	7.91		1	90			5.80
MWDJAR48	50		2.55	2.55	0.057	0.057	94		0.34	0.36	7.93		1	0			7.95
MWDJAR48	50		2.55	2.32	0.057	0.051	94		0.34	0.17	7.93		1	10			7.86
MWDJAR48	50		2.55	2.20	0.057	0.045	94		0.34	0.17	7.93		1	20			7.71
MWDJAR48	50		2.55	2.14	0.057	0.041	94		0.34	0.19	7.93		1	30			7.59
MWDJAR48	50		2.55	1.97	0.057	0.033	94		0.34	0.20	7.93		1	40			7.48
MWDJAR48	50		2.55	1.86	0.057	0.032	94		0.34	0.20	7.93		1	50			7.39
MWDJAR48	50		2.55	1.74	0.057	0.030	94		0.34	0.20	7.93		1	60			7.34
MWDJAR48	50		2.55	1.68	0.057	0.028	94		0.34	0.19	7.93		1	70			7.27
MWDJAR48	50		2.55	1.67	0.057	0.026	94		0.34	0.20	7.93		1	80			7.15
MWDJAR48	50		2.55	1.61	0.057	0.024	94		0.34	0.22	7.93		1	90			7.13
MWDJAR48	50		2.55	1.49	0.057	0.023	94		0.34	0.40	7.93		1	100			7.02
MWDJAR48	50		2.55	1.55	0.057	0.023	94		0.34	0.38	7.93		1	110			6.95
MWDJAR48	50		2.55	1.58	0.057	0.022	94		0.34	0.42	7.93		1	120			6.80
MWDJAR48	50		2.55	1.56	0.057	0.021	94		0.34	0.42	7.93		1	130			6.63
MWDJAR48	50		2.55	1.49	0.057	0.020	94		0.34	0.44	7.93		1	140			6.55
MWDJAR48	50		2.55	1.47	0.057	0.020	94		0.34	0.70	7.93		1	150			6.44
MWDJAR48	50		2.55	1.41	0.057	0.024	94		0.34	1.20	7.93		1	160			6.32

Study ID	Water		TOC		UV-254		Alkalinity		Turbidity		pH		Coagulation Conditions				
	% CRW	% SPW	(mg/L)		(1/cm)		(mg/L as CaCO3)		(NTU)		()		Coagulant	Dose	Acid	Base	Coag.
			Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	ID		adjusted?	adjusted?	pH
													(see above)		(Y/N)	(Y/N)	()
															blank=N	blank=N	
MWDJAR49		100	2.33	2.36	0.077	0.074	73			0.85	8.07		1	0			8.07
MWDJAR49		100	2.33	2.20	0.077	0.064	73			0.57	8.07		1	10			7.65
MWDJAR49		100	2.33	2.19	0.077	0.050	73			0.75	8.07		1	20			7.41
MWDJAR49		100	2.33	2.03	0.077	0.046	73			0.56	8.07		1	30			7.24
MWDJAR49		100	2.33	1.84	0.077	0.043	73			0.72	8.07		1	40			7.15
MWDJAR49		100	2.33	1.75	0.077	0.040	73			0.75	8.07		1	50			7.05
MWDJAR49		100	2.33	1.72	0.077	0.040	73			0.53	8.07		1	60			7.00
MWDJAR49		100	2.33	1.78	0.077	0.037	73			0.47	8.07		1	70			6.87
MWDJAR49		100	2.33	1.42	0.077	0.035	73			0.47	8.07		1	80			6.73
MWDJAR49		100	2.33	1.41	0.077	0.035	73			0.57	8.07		1	90			6.66
MWDJAR49		100	2.33	1.54	0.077	0.030	73			0.56	8.07		1	100			6.58
MWDJAR49		100	2.33	1.31	0.077	0.028	73			0.60	8.07		1	110			6.45
MWDJAR49		100	2.33	1.30	0.077	0.031	73			0.45	8.07		1	120			6.38
MWDJAR49		100	2.33	1.25	0.077	0.029	73			0.60	8.07		1	130			6.23
MWDJAR49		100	2.33	1.20	0.077	0.028	73			0.65	8.07		1	140			6.14
MWDJAR5	100		2.37	2.40	0.048	0.048	131		0.76	0.58	8.23		1	0			8.23
MWDJAR5	100		2.37	2.27	0.048	0.043	131		0.76	0.57	8.23		1	10			7.88
MWDJAR5	100		2.37	2.19	0.048	0.038	131		0.76	0.47	8.23		1	20			7.77
MWDJAR5	100		2.37	2.32	0.048	0.036	131		0.76	0.59	8.23		1	30			7.66
MWDJAR5	100		2.37	2.07	0.048	0.033	131		0.76	0.61	8.23		1	40			7.52
MWDJAR5	100		2.37	1.96	0.048	0.029	131		0.76	0.46	8.23		1	50			7.44
MWDJAR5	100		2.37	1.94	0.048	0.028	131		0.76	0.78	8.23		1	60			7.36
MWDJAR5	100		2.37	1.84	0.048	0.026	131		0.76	0.77	8.23		1	70			7.25
MWDJAR5	100		2.37	1.77	0.048	0.025	131		0.76	0.82	8.23		1	80			7.16
MWDJAR5	100		2.37	1.75	0.048	0.024	131		0.76	0.85	8.23		1	90			7.05
MWDJAR5	100		2.37	1.68	0.048	0.015	131		0.76	0.86	8.23		1	100			7.06
MWDJAR5	100		2.37	1.65	0.048	0.015	131		0.76	1.30	8.23		1	110			6.97
MWDJAR50		100	3.90	4.45	0.110	0.109	77		1.7	1.50	8.00		1	0			8.00
MWDJAR50		100	3.90	3.69	0.110	0.072	77		1.7	0.79	8.00		1	10			7.44
MWDJAR50		100	3.90	3.17	0.110	0.049	77		1.7	0.39	8.00		1	20			7.15
MWDJAR50		100	3.90	2.81	0.110	0.037	77		1.7	0.38	8.00		1	30			6.99
MWDJAR50		100	3.90	2.38	0.110	0.032	77		1.7	0.31	8.00		1	40			6.92
MWDJAR50		100	3.90	2.25	0.110	0.029	77		1.7	0.66	8.00		1	50			6.89
MWDJAR50		100	3.90	2.16	0.110	0.024	77		1.7	0.60	8.00		1	60			6.66
MWDJAR50		100	3.90	2.06	0.110	0.020	77		1.7	0.58	8.00		1	70			6.45
MWDJAR50		100	3.90	1.99	0.110	0.020	77		1.7	0.65	8.00		1	80			6.31
MWDJAR50		100	3.90	2.00	0.110	0.021	77		1.7	0.67	8.00		1	90			6.14
MWDJAR50		100	3.90	2.03	0.110	0.018	77		1.7	1.10	8.00		1	100			5.93
MWDJAR50		100	3.90	1.80	0.110	0.020	77		1.7	0.90	8.00		1	110			5.70
MWDJAR51		100	3.09	3.17	0.097	0.103	81		0.85	2.30	7.80		1	0			7.86
MWDJAR51		100	3.09	2.94	0.097	0.077	81		0.85	0.33	7.80		1	10			7.58
MWDJAR51		100	3.09	3.28	0.097	0.072	81		0.85	0.36	7.80		1	20			7.38
MWDJAR51		100	3.09	2.97	0.097	0.066	81		0.85	0.40	7.80		1	30			7.14
MWDJAR51		100	3.09	2.42	0.097	0.054	81		0.85	0.29	7.80		1	40			7.06
MWDJAR51		100	3.09	2.23	0.097	0.049	81		0.85	0.45	7.80		1	50			7.00
MWDJAR51		100	3.09	2.55	0.097	0.051	81		0.85	0.30	7.80		1	60			6.97
MWDJAR51		100	3.09	2.32	0.097	0.044	81		0.85	0.36	7.80		1	70			6.77
MWDJAR51		100	3.09	2.31	0.097	0.040	81		0.85	0.31	7.80		1	80			6.66
MWDJAR51		100	3.09	2.33	0.097	0.039	81		0.85	0.38	7.80		1	90			6.57
MWDJAR51		100	3.09	2.08	0.097	0.036	81		0.85	0.32	7.80		1	100			6.43
MWDJAR51		100	3.09	1.94	0.097	0.040	81		0.85	0.62	7.80		1	110			6.35
MWDJAR51		100	3.09	1.74	0.097	0.028	81		0.85	0.35	7.80		1	120			6.33
MWDJAR51		100	3.09	1.91	0.097	0.035	81		0.85	0.30	7.80		1	130			6.25
MWDJAR52		100	2.78	2.94		0.080			0.78	0.77	7.72		1	0			7.91
MWDJAR52		100	2.78	2.88		0.061			0.78	0.40	7.72		1	10			7.70
MWDJAR52		100	2.78	2.40		0.051			0.78	0.36	7.72		1	20			7.33
MWDJAR52		100	2.78	2.09		0.048			0.78	0.31	7.72		1	30			7.14
MWDJAR52		100	2.78	1.95		0.040			0.78	0.33	7.72		1	40			7.11
MWDJAR52		100	2.78	1.88		0.034			0.78	0.32	7.72		1	50			6.92
MWDJAR52		100	2.78	1.75		0.031			0.78	0.37	7.72		1	60			6.88
MWDJAR52		100	2.78	1.64		0.028			0.78	0.47	7.72		1	70			6.84
MWDJAR52		100	2.78	1.52		0.026			0.78	0.64	7.72		1	80			6.71
MWDJAR52		100	2.78	1.49		0.025			0.78	0.50	7.72		1	90			6.65
MWDJAR52		100	2.78	1.47		0.025			0.78	0.54	7.72		1	100			6.58
MWDJAR52		100	2.78	1.43		0.024			0.78	0.50	7.72		1	110			6.45
MWDJAR52		100	2.78	1.36		0.023			0.78	0.52	7.72		1	120			6.34
MWDJAR52		100	2.78	1.29		0.023			0.78	0.65	7.72		1	130			6.25
MWDJAR52		100	2.78	1.34		0.024			0.78	1.00	7.72		1	140			6.07
MWDJAR53		100	2.25	2.40	0.065	0.066	79		1.10	0.88	7.98		1	0			7.98
MWDJAR53		100	2.25	2.24	0.065	0.046	79		1.10	0.48	7.98		1	10			7.58
MWDJAR53		100	2.25	1.98	0.065	0.031	79		1.10	0.40	7.98		1	20			7.33
MWDJAR53		100	2.25	2.06	0.065	0.021	79		1.10	0.38	7.98		1	30			7.13
MWDJAR53		100	2.25	1.59	0.065	0.017	79		1.10	0.42	7.98		1	40			7.07
MWDJAR53		100	2.25	1.75	0.065	0.016	79		1.10	0.46	7.98		1	50			6.97
MWDJAR53		100	2.25	1.45	0.065	0.013	79		1.10	0.59	7.98		1	60			6.69
MWDJAR53		100	2.25	1.38	0.065	0.009	79		1.10	0.74	7.98		1	70			6.61
MWDJAR53		100	2.25	1.29	0.065	0.008	79		1.10	0.69	7.98		1	80			6.54
MWDJAR53		100	2.25	1.43	0.065	0.007	79		1.10	0.69	7.98		1	90			6.46
MWDJAR53		100	2.25	1.21	0.065	0.006	79		1.10	0.90	7.98		1	100			6.33
MWDJAR53		100	2.25	1.19	0.065	0.006	79		1.10	0.90	7.98		1	110			6.29
MWDJAR54		100	2.92	3.21	0.087	0.091	72		0.52	0.55	7.87		1	0			7.90
MWDJAR54		100	2.92	2.91	0.087	0.070	72		0.52	0.70	7.87		1	10			7.64
MWDJAR54		100	2.92	2.33	0.087	0.051	72		0.52	0.59	7.87		1	20			7.54
MWDJAR54		100	2.92	2.55	0.087	0.043	72		0.52	0.52	7.87		1	30			7.35
MWDJAR54		100	2.92	2.05	0.087	0.039	72		0.52	0.47	7.87		1	40			7.15
MWDJAR54		100	2.92	1.91	0.087	0.037	72		0.52	0.45	7.87		1	50			7.11
MWDJAR54		100	2.92	1.63	0.087	0.030	72		0.52	0.52	7.87		1	60			6.87
MWDJAR54		100	2.92	1.49	0.087	0.025	72		0.52	0.49	7.87		1	70			6.85
MWDJAR54		100	2.92	1.55	0.087	0.022	72		0.52	0.45	7.87		1	80			6.72
MWDJAR54		100	2.92	1.42	0.087	0.018	72		0.52	0.57	7.87		1	90			6.55
MWDJAR54		100	2.92	1.44	0.087	0.015	72		0.52	0.64	7.87		1	100			6.49
MWDJAR54		100	2.92	1.38	0.087	0.014	72		0.52	0.56	7.87		1	110			6.37

Study ID	Water		TOC		UV-254		Alkalinity		Turbidity		pH		Coagulation Conditions				
	% CRW	% SPW	(mg/L)		(1/cm)		(mg/L as CaCO3)		(NTU)		()		Coagulant	Dose	Acid	Base	Coag.
			Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	ID		adjusted?	adjusted?	pH
													(see above)		(Y/N)	(Y/N)	()
															blank=N	blank=N	
MWDJAR54		100	2.92	1.30	0.087	0.014	72		0.52	0.62	7.87		1	120			6.12
MWDJAR54		100	2.92	1.27	0.087	0.013	72		0.52	0.68	7.87		1	130			6.08
MWDJAR54		100	2.92	1.22	0.087	0.014	72		0.52	0.81	7.87		1	140			5.93
MWDJAR54		100	2.92	1.25	0.087	0.014	72		0.52	0.98	7.87		1	150			5.69
MWDJAR54		100	2.92	1.23	0.087	0.021	72		0.52	1.30	7.87		1	160			5.51
MWDJAR55		100	2.68	2.65	0.086	0.083	62		0.72	0.55	7.82		1	0			7.77
MWDJAR55		100	2.68	2.43	0.086	0.061	62		0.72	0.42	7.82		1	10			7.52
MWDJAR55		100	2.68	2.34	0.086	0.051	62		0.72	0.74	7.82		1	20			7.35
MWDJAR55		100	2.68	2.00	0.086	0.040	62		0.72	0.24	7.82		1	30			7.18
MWDJAR55		100	2.68	1.76	0.086	0.036	62		0.72	0.29	7.82		1	40			7.12
MWDJAR55		100	2.68	1.76	0.086	0.032	62		0.72	0.30	7.82		1	50			7.20
MWDJAR55		100	2.68	1.58	0.086	0.030	62		0.72	0.28	7.82		1	60			7.08
MWDJAR55		100	2.68	1.40	0.086	0.029	62		0.72	0.24	7.82		1	70			6.97
MWDJAR55		100	2.68	1.45	0.086	0.027	62		0.72	0.25	7.82		1	80			6.84
MWDJAR55		100	2.68	1.40	0.086	0.024	62		0.72	0.31	7.82		1	90			6.67
MWDJAR55		100	2.68	1.34	0.086	0.023	62		0.72	0.25	7.82		1	100			6.50
MWDJAR55		100	2.68	1.47	0.086	0.024	62		0.72	0.74	7.82		1	110			6.45
MWDJAR55		100	2.68	1.31	0.086	0.024	62		0.72	0.44	7.82		1	120			6.20
MWDJAR55		100	2.68	1.34	0.086	0.021	62		0.72	0.63	7.82		1	130			5.95
MWDJAR55		100	2.68	1.33	0.086	0.022	62		0.72	0.50	7.82		1	140			5.83
MWDJAR55		100	2.68	1.30	0.086	0.022	62		0.72	0.72	7.82		1	150			5.52
MWDJAR55		100	2.68	1.32	0.086	0.021	62		0.72	0.72	7.82		1	160			5.30

Utility ID:	MWD	(ACWD, CCWD, EBMUD, MWD, SCVWD)		
1. Study ID:	EC Study Data	(Optimization Study 9/95, etc.)		
2. Source water:	SPW / CRW	(River, lake, groundwater, etc.)		
3. Source water ID:		(State Project water, blend of....., etc.)		
5. Describe level of study:				
(indicate with an 'X')		Bench-scale	In this data sheet, "Filt." refers to data collected	
		Pilot-scale	after coagulation, flocculation, sedimentation, and	
	X	Full-scale	filtration.	
6. Indicate with an 'X' if data reported as "Filt." are from samples collected after sedimentation only:				
			or after sedimentation and filtration:	

WATER QUALITY DATA: CONVENTIONAL

Study ID	Water		TOC (mg/L)		UV-254 (1/cm)		Alkalinity (mg/L as CaCO3)		Turbidity (NTU)		pH ()		Temperature (deg. C)		Fi	
	SPW	CRW	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	dicate disinfectant used with an 'X'	Chlorine dose
															chlorine	hloramin (mg Cl2/L
MWDODP1	X		2.45	1.88	0.073	0.026	74		2.10		8.90		11.2			0.5 mg/L Cl2 thru floc basin; 1.7 mg/
MWDODP1	X		2.41	1.86	0.069	0.020	74		2.10		8.20		10.3			0.5 mg/L Cl2 thru floc basin; 1.7 mg/
MWDODP1	X		2.33	1.71	0.068	0.026	74		2.30		8.10		10.1			0.5 mg/L Cl2 thru floc basin; 1.7 mg/
MWDODP1	X		2.28	1.70	0.064	0.024	74		2.00		8.00		10.9			0.5 mg/L Cl2 thru floc basin; 1.7 mg/
MWDODP1	X		2.48	1.80	0.073	0.026	74		1.80		8.50		10.8			0.5 mg/L Cl2 thru floc basin; 1.7 mg/
MWDODP2	X		2.26	1.35	0.070	0.027	78		0.93		7.95		11.5			1.0 mg/L Cl2, 1 hr @ 25oC
MWDODP2	X		2.31	1.43	0.068	0.028	78		1.60		7.96		10.8			1.0 mg/L Cl2, 1 hr @ 25oC
MWDODP2	X		2.34	1.59	0.065	0.030	78		1.50		8.03		11.0			1.0 mg/L Cl2, 1 hr @ 25oC
MWDODP2	X		2.21	1.42	0.069	0.028	78		1.20		7.92		11.2			1.0 mg/L Cl2, 1 hr @ 25oC
MWDODP3	X		2.47	2.31	0.036	0.036	131		0.98		8.30		12.0			1.0 mg/L Cl2, 1 hr @ 25oC
MWDODP3	X		2.51	2.08	0.036	0.027	131		0.80		8.41		12.0			1.0 mg/L Cl2, 1 hr @ 25oC
MWDODP3	X		2.31	1.90	0.033	0.024	131		0.88		8.34		11.5			1.0 mg/L Cl2, 1 hr @ 25oC
MWDODP4	X		2.05	1.10	0.033	0.014	131		0.76		8.33		12.0			1.0 mg/L Cl2, 1 hr @ 25oC
MWDODP5	X		2.27	2.24	0.076	0.071	81		1.40		8.60		11.7			1.0 mg/L Cl2, 1 hr @ 25oC
MWDODP5	X		2.42	1.98	0.078	0.070	81		1.30		8.63		11.7			1.0 mg/L Cl2, 1 hr @ 25oC
MWDODP5	X		2.78	1.95	0.087	0.044	70		1.90		7.97		9.3			1.0 mg/L Cl2, 1 hr @ 25oC
MWDODP5	X		2.43	1.82	0.074	0.044	81		1.40		8.69		11.7			1.0 mg/L Cl2, 1 hr @ 25oC
MWDODP5	X		2.71	1.81	0.079	0.036	75		1.48		8.46		10.9			1.0 mg/L Cl2, 1 hr @ 25oC
MWDODP5	X		2.64	1.65	0.074	0.028	75		1.20		8.41		11.2			1.0 mg/L Cl2, 1 hr @ 25oC
MWDODP5	X		2.76	1.63	0.083	0.023	70		1.80		7.91		9.1			1.0 mg/L Cl2, 1 hr @ 25oC
MWDODP5	X		2.28	1.59	0.068	0.039	81		1.60		8.70		11.8			1.0 mg/L Cl2, 1 hr @ 25oC
MWDODP5	X		2.62	1.62	0.077	0.027	75		1.30		8.53		11.1			1.0 mg/L Cl2, 1 hr @ 25oC
MWDODP6	X		2.65	1.88	0.072	0.030	76		2.10		8.44		11.0			1.0 mg/L Cl2, residual, 1 hr @ 25oC
MWDODP6	X		2.62	1.68	0.080	0.024	76		2.00		8.37		10.9			1.0 mg/L Cl2, residual, 1 hr @ 25oC
MWDODP6	X		2.67	1.51	0.078	0.018	70		2.10		8.01		9.2			1.0 mg/L Cl2, residual, 1 hr @ 25oC
MWDODP6	X		2.70	1.25	0.066	0.012	76		1.90		8.37		11.0			1.0 mg/L Cl2, residual, 1 hr @ 25oC
MWDODP6	X		2.62	1.38	0.074	0.019	75		1.20		8.46		11.1			1.0 mg/L Cl2, residual, 1 hr @ 25oC
MWDODP6	X		2.76	1.24	0.076	0.014	70		2.20		7.97		9.2			1.0 mg/L Cl2, residual, 1 hr @ 25oC
MWDODP6	X		2.67	1.19	0.080	0.022	76		1.80		8.31		10.9			1.0 mg/L Cl2, residual, 1 hr @ 25oC
MWDOP1	92-99%		2.94	2.71	0.084	0.064	76		0.55		7.90		11.7			1.0 mg/L Cl2, 1 hr @ 25oC
MWDOP1	92-99%		2.77	2.55	0.086	0.082			0.50		7.83		12.1			1.0 mg/L Cl2, 1 hr @ 25oC
MWDOP1	92-99%		2.79	2.37	0.088	0.062	71		2.20		8.05		9.2			1.0 mg/L Cl2, 1 hr @ 25oC
MWDOP1	92-99%		2.59	2.17	0.083	0.060			1.50		7.96		10.2			1.0 mg/L Cl2, 1 hr @ 25oC
MWDOP1	92-99%		2.84	1.46	0.084	0.022	71		1.60		8.27		10.6			1.0 mg/L Cl2, 1 hr @ 25oC
MWDOP1	92-99%		2.60	1.42	0.083	0.027	72		1.50		8.14		11.3			1.0 mg/L Cl2, 1 hr @ 25oC
MWDOP1	92-99%		2.74	1.53	0.078	0.022			1.80		8.55		12.6			1.0 mg/L Cl2, 1 hr @ 25oC
MWDOP1	92-99%		3.30	2.02	0.091	0.036			3.10		9.22		14.9			1.0 mg/L Cl2, 1 hr @ 25oC
MWDOP1	92-99%		3.20	1.99	0.099	0.035	75		2.10		8.60		13.5			1.0 mg/L Cl2, 1 hr @ 25oC
MWDOP1	92-99%		3.43	2.03	0.103	0.039	77		1.75		8.51		14.3			1.0 mg/L Cl2, 1 hr @ 25oC
MWDOP1	92-99%		2.78	1.58	0.072	0.029	73		0.72		7.83		11.3			1.0 mg/L Cl2, 1 hr @ 25oC
MWDOP2	92-100%		3.46	3.01	0.108	0.099	80		1.60		8.36		17.4			1.0 mg/L Cl2, 1 hr @ 25oC
MWDOP2	92-100%		3.37	2.99	0.088	0.063			2.00		8.14		17.5			1.0 mg/L Cl2, 1 hr @ 25oC
MWDOP3	92-100%		3.26	1.93	0.111	0.036			1.55		8.34		16.6			1.0 mg/L Cl2, 1 hr @ 25oC
MWDOP3	92-100%		3.49	2.07	0.120	0.043	78		1.60		8.24		16.1			1.0 mg/L Cl2, 1 hr @ 25oC
MWDOP3	92-100%		3.53	2.07	0.111	0.040	79		1.80		8.18		16.6			1.0 mg/L Cl2, 1 hr @ 25oC
MWDOP3	92-100%		3.67	2.12	0.115	0.040			1.60		8.24		16.2			1.0 mg/L Cl2, 1 hr @ 25oC
MWDOP3	92-100%		3.05	1.85	0.100	0.036			2.10		7.99		21.1			1.0 mg/L Cl2, 1 hr @ 25oC
MWDOP3	92-100%		3.29	1.81	0.104	0.043	80		2.70		8.03		18.9			1.0 mg/L Cl2, 1 hr @ 25oC
MWDOP3	92-100%		3.20	1.85	0.102	0.033			2.90		8.09		18.8			1.0 mg/L Cl2, 1 hr @ 25oC
MWDOP3	92-100%		3.17	1.85	0.103	0.032	81		2.70		8.11		17.8			1.0 mg/L Cl2, 1 hr @ 25oC
MWDOP4	X		3.54	3.60	0.106	0.097	85		1.49		7.85		21.7			1 mg/L resid, 1 hr, 25 oC
MWDOP4	X		3.54	3.80	0.106	0.100	85		1.49		7.85		21.7			1 mg/L resid, 1 hr, 25 oC
MWDOP4	X		3.54	3.50	0.106	0.091	85		1.49		7.85		21.7			1 mg/L resid, 1 hr, 25 oC
MWDOP4	X		3.54	2.86	0.106	0.067	85		1.49		7.85		21.7			1 mg/L resid, 1 hr, 25 oC
MWDOP4	X		3.54	3.01	0.106	0.073	85		1.49		7.85		21.7			1 mg/L resid, 1 hr, 25 oC
MWDOP4	X		3.54	3.01	0.106	0.082	85		1.49		7.85		21.7			1 mg/L resid, 1 hr, 25 oC

Study ID	Water		TOC		UV-254		Alkalinity		Turbidity		pH		Temperature				
	SPW	CRW	(mg/L)		(1/cm)		(mg/L as CaCO3)		(NTU)		()		(deg. C)				Fi
			Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	dicate disinfectant		Chlorine
															used with an 'X'		dose
															chlorine	hloramin	(mg Cl2/L
MWDOP4	X		3.54	3.07	0.106	0.077	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	3.02	0.106	0.069	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	2.55	0.106	0.055	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	2.50	0.106	0.052	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	2.37	0.106	0.051	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	2.23	0.106	0.045	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	2.74	0.106	0.059	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	2.82	0.106	0.060	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	2.31	0.106	0.048	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	2.51	0.106	0.048	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	2.12	0.106	0.042	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	2.14	0.106	0.037	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	2.88	0.106	0.059	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	2.57	0.106	0.052	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	2.20	0.106	0.046	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	2.05	0.106	0.037	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	2.01	0.106	0.041	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	1.92	0.106	0.046	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	1.78	0.106	0.033	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP5		X	2.44	2.12	0.039	0.031	131.5		0.65		7.7		24.6		1 mg/L resid, 1 hr, 25 °C		
MWDOP5		X	2.44	2.16	0.039	0.028	131.5		0.65		7.7		24.6		1 mg/L resid, 1 hr, 25 °C		
MWDOP5		X	2.44	1.97	0.039	0.024	131.5		0.65		7.7		24.6		1 mg/L resid, 1 hr, 25 °C		
MWDOP5		X	2.44	1.85	0.039	0.021	131.5		0.65		7.7		24.6		1 mg/L resid, 1 hr, 25 °C		
MWDOP5		X	2.44	1.80	0.039	0.023	131.5		0.65		7.7		24.6		1 mg/L resid, 1 hr, 25 °C		
MWDOP5		X	2.44	1.81	0.039	0.020	131.5		0.65		7.7		24.6		1 mg/L resid, 1 hr, 25 °C		
MWDOP5		X	2.44	1.99	0.039	0.024	131.5		0.65		7.7		24.6		1 mg/L resid, 1 hr, 25 °C		
MWDOP5		X	2.44	1.73	0.039	0.020	131.5		0.65		7.7		24.6		1 mg/L resid, 1 hr, 25 °C		

Utility ID:													
1. Study ID:													
2. Source wat													
3. Source wat													
								indicate coagulants studied:					
5. Describe le								ID	oagula	Chemical formula		Units	
(indicate with								1	Alum	$Al_2(SO_4)_3$*14 H_2O		mg/L	
								2	Ferric	$FeCl_3$*6 H_2O		mg/L	
								3					
6. Indicate wit								4					
									Polymer added: 2, 3, 0.5 mg/L				
WATER QU								TREATMENT CONDITIONS					

Study ID				Disinfection By-products				Coagulation Conditions					
	ered			TTHM		HAA5		Coagulant	Dose	Acid	Base	Coag.	Coag.
	mmoni	bubation t	Residual	(µg/L)		(µg/L)		ID		adjusted?	adjusted?	pH	temp.
	dose	(h)		Raw	Filt.	Raw	Filt.	(see above)		(Y/N)	(Y/N)	()	(deg. C)
	g NH3-N	chlorine	(mg Cl2/L)										
MWDODP1	Cl2 thru filters				40.6			1	40			7.00	
MWDODP1	Cl2 thru filters							1	40			7.00	
MWDODP1	Cl2 thru filters				35.1		30.1	1	40			7.00	
MWDODP1	Cl2 thru filters							1	40			7.00	
MWDODP1	Cl2 thru filters				37.2		31.7	1	40			6.90	
MWDODP2					30.7		12.4	1	30	Y		6.40	
MWDODP2					32.9		12.0	1	35	Y		6.46	
MWDODP2					35.8		14.4	1	40	Y		7.03	
MWDODP2					29.9		12.2	1	40	Y		6.56	
MWDODP3					29.0		12.4	2	5			7.91	
MWDODP3					24.8		11.0	2	10			7.97	
MWDODP3					20.5		10.6	2	25			7.14	
MWDODP4					14.0		7.7	2	25	Y		5.59	
MWDODP5					45.5		19.3	2	5			7.90	
MWDODP5					40.9		15.4	2	10			7.54	
MWDODP5					35.4		16.1	2	15			7.13	
MWDODP5					33.9		14.0	2	20			7.23	
MWDODP5					31.7		19.3	2	20			7.20	
MWDODP5					29.4		20.2	2	25			6.97	
MWDODP5					28.4		15.6	2	25			6.95	
MWDODP5					33.8		14.6	2	30			7.18	
MWDODP5					26.1		15.3	2	30			6.86	
MWDODP6					33.2		17.8	2	10	Y		6.98	
MWDODP6					28.4		12.2	2	10	Y		6.24	
MWDODP6					27.7		12.7	2	15	Y		6.25	
MWDODP6					21.2		8.9	2	20	Y		6.25	
MWDODP6					24.1		15.6	2	20	Y		6.15	
MWDODP6					22.3		11.8	2	25	Y		6.15	
MWDODP6					20.3		9.0	2	30	Y		6.22	
MWDOP1					50.8		25.9	2	3			7.60	
MWDOP1					49.8		29.2	2	3			7.53	
MWDOP1								2	5			7.56	
MWDOP1					48.6		22.8	2	5			7.53	
MWDOP1					28.3		16.2	2	30			6.86	
MWDOP1					28.2		14.5	2	30			6.80	
MWDOP1					32.0		16.1	2	30			6.77	
MWDOP1					37.8		16.9	2	30			7.09	
MWDOP1					36.1		17.1	2	30			6.94	
MWDOP1					36.0		17.8	2	30			6.92	
MWDOP1					31.4		14.3	2	30			6.88	
MWDOP2					68.2		30.3	1	12			7.71	
MWDOP2					66.5		29.5	1	12			7.65	
MWDOP3					43.0		16.9	1	40	Y		6.41	
MWDOP3					38.3		17.9	1	40	Y		6.41	
MWDOP3					41.4		17.0	1	40	Y		6.37	
MWDOP3					38.0		17.1	1	40	Y		6.33	
MWDOP3					41.6		16.5	1	40	Y		6.43	
MWDOP3					39.4		16.4	1	40	Y		6.34	
MWDOP3					39.9		18.2	1	40	Y		6.33	
MWDOP3					36.7		16.4	1	40	Y		6.31	
MWDOP4					77.9		34.0	1	10	Y		7.82	
MWDOP4					75.7		33.7	1	10	Y		7.71	
MWDOP4					71.1		31.6	1	10	Y		7.00	
MWDOP4					59.6		25.1	1	10	Y		6.23	
MWDOP4					67.7		26.7	1	10	Y		5.41	
MWDOP4					70.8		< 32.5	1	20	Y		7.65	

Study ID				Disinfection By-products				Coagulation Conditions					
	ered			TTHM		HAA5		Coagulant	Dose	Acid	Base	Coag.	Coag.
	mmoni	bubation t	Residual	(µg/L)		(µg/L)		ID		adjusted?	adjusted?	pH	temp.
	dose	(h)		Raw	Filt.	Raw	Filt.	(see above)		(Y/N)	(Y/N)	()	(deg. C)
	g NH3-N	chlorine	(mg Cl2/L)										
MWDOP4					67.4		29.4	1	20	Y		7.17	
MWDOP4					62.7		< 28.9	1	20	Y		7.11	
MWDOP4					54.9		< 22.3	1	20	Y		6.34	
MWDOP4					49.9		21.0	1	20	Y		6.40	
MWDOP4					53.1		20.9	1	20	Y		5.52	
MWDOP4					52.2		22.4	1	20	Y		5.71	
MWDOP4					62.1		23.8	1	30	Y		7.26	
MWDOP4					63.5		<24.7	1	30	Y		7.05	
MWDOP4					53.0		< 21.1	1	30	Y		6.26	
MWDOP4					53.8		<20.3	1	30	Y		6.50	
MWDOP4					48.1		<17.8	1	30	Y		6.23	
MWDOP4					46.7		<21.5	1	30	Y		5.43	
MWDOP4					56.4		24.9	1	40	Y		6.97	
MWDOP4					57.1		25.3	1	40	Y		7.24	
MWDOP4					52.4		< 21.5	1	40	Y		6.30	
MWDOP4					43.9		<18.7	1	40	Y		6.19	
MWDOP4					45.9		< 18.0	1	40	Y		5.65	
MWDOP4					46.1		< 18.6	1	40	Y		5.74	
MWDOP4					43.6		<15.8	1	40	Y		5.42	
MWDOP5					22.2		11.7	1	10	Y		5.88	
MWDOP5					22.0		14.7	1	20	Y		7.58	
MWDOP5					18.7		11.1	1	20	Y		6.89	
MWDOP5					16.6		9.5	1	20	Y		6.50	
MWDOP5					17.4		9.2	1	20	Y		5.75	
MWDOP5					17.5		< 10.6	1	20	Y		5.31	
MWDOP5					18.7		9.8	1	40	Y		6.90	
MWDOP5					16.3		9.2	1	40	Y		5.53	

Utility ID: MWDSC (ACWD, CCWD, EBMUD, MWD, SCVWD)

1. Study ID: Oxidation Demonstration Project (Optimization Study 9/95, etc.)

2. Source water: River (River, lake, groundwater, etc.)

3. Source water ID: California State Project Water (State Project water, blend of ..., etc.)

4. If blended source water indicate sources and proportions:

Source	%

5. Describe level of study: (indicate with an "X")

	Bench-scale
	Pilot-scale
X	Full-scale

In this data sheet, "Filt." refers to data collected after coagulation, flocculation, sedimentation, and filtration.

6. Indicate with an "X" if data reported as "Filt." are from samples collected after sedimentation only:
or after sedimentation and filtration: X

WATER QUALITY DATA: PRE-OZONE

Date	TOC (mg/L)			UV-254 (1/cm)			Alkalinity (mg/L as CaCO3)			Bromide [illegible]			Turbidity (NTU)			pH ()			Temperature (deg. C)			Bromate (µg/L)		
	Raw	Ozon.	Filt.	Raw	Ozon.	Filt.	Raw	Ozon.	Filt.	Raw	Ozon.	Filt.	Raw	Ozon.	Filt.	Raw	Ozon.	Filt.	Raw	Ozon.	Filt.	Raw	Ozon.	Filt.
09/08/92	3.86			0.116	0.089		87				0.31		1.8			8.07	8.07		26.7				9.0	
09/08/92	3.86	3.82		0.118	0.081		87				0.31		1.5			7.96	7.96		25.8				12.0	
09/09/92				0.114	0.084						0.31		2.3			7.89	7.89		25.0				10.0	
09/09/92				0.113	0.085						0.31		2.4			7.89	7.89		25.0				11.0	
09/10/92				0.113	0.085						0.30		1.8			7.91	7.91		24.4				7.0	
09/10/92				0.114	0.081						0.30		1.5			8.00	8.00		24.4				11.0	
09/10/92				0.118	0.078						0.30		1.5			8.01	8.01		25.8				13.0	
09/18/92				0.108	0.078								1.8				6.67		22.3				8.0	
09/21/92				0.110												7.96	7.33		23.2				8.0	
09/21/92				0.110	0.084								1.8			7.96	7.96		23.2				7.0	
09/22/92																	7.34		23.2				6.0	
09/22/92																	7.18		23.2				7.0	
09/23/92	3.32			0.109	0.079		87				0.31		1.6			8.02	8.02		23.1				8.0	
09/24/92					0.072								1.8			8.02	6.20		23.3				3.0	
09/24/92					0.079								1.8			8.02	6.18		23.3				4.5	
09/24/92					0.087								1.6			8.02	6.06		23.3				6.5	
10/06/92	3.27			0.105			85				0.34		1.8			7.81	6.17		21.7				1.5	
10/06/92	3.27			0.105			85				0.34		1.8			7.81	6.20		21.7				6.0	
10/12/92																	8.06		21.0				1.5	
10/12/92																	8.02		21.0				1.5	
10/12/92																	6.03		21.0				1.5	
10/13/92																	7.32		20.9				1.5	
10/13/92																	7.08		20.9				5.0	
10/14/92																	7.15		20.8				5.0	
10/14/92																	7.06		20.8				7.0	
10/14/92																	7.06		20.8				7.5	
10/20/92																7.97	7.97		19.9				13.0	
10/20/92																7.97	7.97		19.9				15.5	
10/20/92																7.97	7.97		19.9				23.5	
10/26/92																7.92	7.92		19.5				13.0	
10/26/92																7.92	7.92		19.5				16.5	
10/26/92																7.92	7.92		19.5				19.0	
01/21/93	3.50						73				0.34		3.1			7.81	7.81		10.0				9.5	
01/21/93	3.50						73				0.34		3.1			7.81	7.81		10.0				15.5	
01/21/93	3.50						73				0.34		3.1			7.81	7.81		10.0				23.0	
03/16/93	2.84			0.099							0.19					7.72	7.72		12.0				3.0	
03/16/93	2.84			0.099							0.19					7.72	7.72		12.0				5.5	
03/16/93	2.84			0.099							0.19					7.72	7.72		12.0				5.5	
04/01/93													2.2			7.68	6.01		12.0				1.5	
04/01/93													2.2			7.68	6.11		12.0				1.5	
04/01/93													2.2			7.68	5.90		12.0				1.5	
04/01/93													2.2			7.68	5.99		12.0				1.5	
04/01/93													2.2			7.68	6.07		12.0				5.0	
04/02/93													2.3			7.66	7.66		12.0				1.5	
04/02/93													2.3			7.66	7.66		12.0				3.5	
04/02/93													2.3			7.66	7.66		12.0				4.5	
04/02/93													2.3			7.66	7.66		12.0				1.5	
04/02/93													2.3			7.66	7.66		12.0				13.0	
04/05/93	2.78			0.098			72				0.19					7.50	7.50		12.2				8.0	
04/05/93	2.78			0.098			72				0.19					7.50	7.50		12.2				43.5	
04/06/93																	5.93		12.3				3.0	
04/06/93																	6.06		12.3				5.0	
04/07/93											0.19		1.3			7.58	6.13		12.1				3.5	
04/07/93											0.18		1.3			7.58	6.18		12.1				1.5	
04/07/93											0.18		1.3			7.58	5.96		12.1				3.5	
04/07/93											0.34		1.3			7.58	5.92		12.1				3.0	
04/07/93											0.28		1.3			7.58	5.83		12.1				1.5	
04/08/93											0.33		1.3			7.60	7.60		12.1				8.0	
04/08/93											0.19		1.3			7.60	7.60		12.1				6.0	
04/08/93											0.21		1.3			7.60	7.60		12.1				6.0	
04/08/93											0.27		1.3			7.60	7.60		12.1				7.5	
04/08/93											0.17		1.3			7.60	7.60		12.1				6.0	
04/12/93	2.78			0.095			73				0.47					7.57	7.57		12.1				3.5	
04/21/93																	6.15		13.0				1.5	

TREATMENT CONDITIONS

Date	Ozone dose (mg/L)	Ozone residual (mg/L)	Contact time (min) (full contactor)	Ozone pH ()	Ozone temp. (deg. C)	Ozone residual (mg/L) Ch. 1A	Ozone residual (mg/L) Ch. 1B	Ozone residual (mg/L) Ch. 2A	Ozone residual (mg/L) Ch. 2B	Ozone residual (mg/L) Ch. 3A	Ozone residual (mg/L) Ch. 3B
09/08/92	1.9		12.1			0.32	<.01	<.01	<.01	<.01	<.01
09/08/92	2.0		12.1			0.42	0.02	0.01	<.01	<.01	0.01
09/09/92	1.9		12.2			0.31	0.04	0.04	0.04	0.05	0.04
09/09/92	1.9		12.0			0.32	0.02	0.01	0.01	0.01	0.01
09/10/92	1.6		12.3			0.18	<.01	<.01	<.01	<.01	<.01
09/10/92	1.9		12.3			0.32	0.01	0.01	<.01	<.01	<.01
09/10/92	2.2		12.2			0.44	0.03	0.03	0.03	0.02	0.02
09/18/92	1.7		12.1			0.40	0.11	0.03	0.03	0.02	0.02
09/21/92	1.5		12.2			0.34	0.05	0.05	0.04	0.03	0.04
09/21/92	1.6		12.2			0.25	0.04	0.03	0.04	0.03	0.03
09/22/92	1.3		12.1			0.26	0.03	0.03	0.03	0.02	0.02
09/22/92	1.4		12.2			0.27	0.04	0.03	0.03	0.03	0.03
09/23/92	1.7		12.3			0.36	0.03	0.03	0.03	0.03	0.03
09/24/92	1.2		12.2			0.30	0.04	0.04	0.04	0.03	0.04
09/24/92	1.5		12.3			0.51	0.09	0.04	0.04	0.03	0.03
09/24/92	1.7		12.2			0.75	0.18	0.10	0.04	0.04	0.04
10/06/92	1.0		12.1			0.20	0.02	0.02	0.02	0.02	0.01
10/06/92	1.2		12.3			0.34	0.04	0.02	0.02	0.02	0.02
10/12/92	1.0		12.2			0.20	0.02	0.01	0.01	<0.010	0.01
10/12/92	1.1		12.1			0.24	0.02	0.02	0.02	0.02	0.02
10/12/92	1.1		12.1			0.33	0.03	0.02	0.02	0.02	0.01
10/13/92	1.1		12.2			0.23	0.03	0.02	0.02	0.02	0.02
10/13/92	1.1		12.2			0.32	0.01	0.02	0.02	0.01	0.01
10/14/92	1.0		12.3			0.22	0.02	0.01	0.01	<0.010	<0.010
10/14/92	1.2		12.3			0.34	0.01	<0.010	<0.010	<0.010	<0.010
10/14/92	1.4		12.3			0.42	0.06	0.02	0.01	0.01	<0.010
10/20/92	1.8		6.1			0.59	0.11	0.04	<0.010	<0.010	<0.010
10/20/92	1.8		6.1			0.68	0.11	0.14	0.02	<0.010	<0.010
10/20/92	2.1		6.1			0.72	0.29	0.28	0.11	0.06	0.03
10/26/92	1.4		12.2			0.42	0.08	0.04	0.04	0.04	0.04
10/26/92	1.7		12.2			0.42	0.04	0.03	0.03	0.03	0.03
10/26/92	2.0		12.2			0.67	0.10	0.06	0.03	0.03	0.03
01/21/93	1.8		11.9			0.58	0.19	0.05	<0.010	<0.010	<0.010
01/21/93	1.9		12.2			0.78	0.23	0.11	0.03	<0.010	<0.010
01/21/93	2.2		12.1			0.88	0.47	0.22	0.09	0.05	0.01
03/16/93	1.0		12.3			0.21	<0.010	<0.010	<0.010	<0.010	<0.010
03/16/93	1.5		12.3			0.56	0.27	0.08	0.04	0.03	0.03
03/16/93	2.0		12.2			0.78	0.31	0.21	0.09	0.05	0.03
04/01/93	0.8		12.2			0.11	<0.010	0.01	0.01	0.02	<0.010
04/01/93	1.0		12.2			0.26	0.02	0.01	<0.010	0.01	0.01
04/01/93	1.2		12.2			0.45	0.10	0.06	0.03	0.03	0.03
04/01/93	1.5		12.2			0.70	0.36	0.24	0.13	0.08	0.05
04/01/93	1.8		12.2			0.88	0.44	0.38	0.31	0.23	0.18
04/02/93	1.0		12.2			0.23	0.02	0.02	0.01	0.02	0.02
04/02/93	1.3		12.2			0.44	0.07	0.02	0.02	0.02	0.02
04/02/93	1.5		12.2			0.46	0.09	0.05	0.02	0.02	0.02
04/02/93	1.7		12.1			0.83	0.33	0.19	0.08	0.03	0.02
04/02/93	2.0		12.1			1.07	0.44	0.31	0.17	0.10	0.04
04/05/93	1.6		12.2			0.74	0.18	0.11	0.02	0.02	0.02
04/05/93	4.0		12.2			2.01	1.71	1.56	1.30	1.09	0.97
04/06/93	1.3		12.2			0.54	0.15	0.09	0.04	0.04	0.05
04/06/93	1.6		12.2			0.75	0.30	0.25	0.18	0.12	0.08
04/07/93	1.2		12.2			0.41	0.05	0.01	0.01	0.02	0.02
04/07/93	1.2		12.2			0.39	0.08	0.05	0.04	0.03	0.04
04/07/93	1.2		12.2			0.38	0.07	0.04	0.01	0.02	0.01
04/07/93	1.2		12.1			0.47	0.10	0.06	0.02	0.02	0.02
04/07/93	1.2		12.1			0.40	0.11	0.06	0.02	0.02	0.02
04/08/93	1.5		12.1			0.52	0.18	0.08	0.03	0.04	0.04
04/08/93	1.5		12.2			0.46	0.10	0.06	0.03	0.03	0.03
04/08/93	1.5		12.2			0.57	0.16	0.06	0.03	0.03	0.02
04/08/93	1.5		12.1			0.61	0.14	0.03	0.02	0.02	0.02
04/08/93	1.5		12.2			0.53	0.08	0.03	0.01	0.02	0.01
04/12/93	1.0		12.2			0.23	0.01	<0.010	<0.010	<0.010	<0.010
04/21/93	0.7		12.1			0.13	0.03	0.03	0.03	0.02	0.02

D—042264

Date	TOC (mg/L)			UV-254 (1/cm)			Alkalinity (mg/L as CaCO3)			Bromide (mg/L)			Turbidity (NTU)			pH ()			Temperature (deg. C)			Bromate (ug/L)			Ozonation Conditions								
	Raw	Ozon.	Fin.	Raw	Ozon.	Fin.	Raw	Ozon.	Fin.	Raw	Ozon.	Fin.	Raw	Ozon.	Fin.	Raw	Ozon.	Fin.	Raw	Ozon.	Fin.	Raw	Ozon.	Fin.	Ozone dose (mg/L)	Ozone residual (mg/L)	Contact time (min) (full contactor)	Ozone pH ()	Ozone temp. (deg. C)	Ozone residual (mg/L) Ch. 1A	Ozone residual (mg/L) Ch. 1B	Ozone residual (mg/L) Ch. 2A	Ozone residual (mg/L) Ch. 2B	Ozone residual (mg/L) Ch. 3A	Ozone residual (mg/L) Ch. 3B
04/21/93																	6 11			13 0				1 5		1 0		12 1			0 19	0 02	0 01	0 02	0 03	0 02
04/21/93																	5 98			13 0				1 5		1 3		12 2			0 36	0 08	0 03	0 02	0 02	0 03
04/21/93																	6 06			13 0				3 0		1 5		12 3			0 58	0 15	0 09	0 02	0 02	0 02
04/21/93																	5 99			13 0				3 5		1 7		12 2			0 77	0 28	0 17	0 12	0 07	0 04
04/22/93																	7 30			13 2				1 5		1 0		12 3			0 19	<0 010	<0 010	<0 010	<0 010	<0 010
04/22/93																	7 30			13 2				1 5		1 2		12 3			0 25	0 04	0 01	0 01	0 01	<0 010
04/22/93																	7 30			13 2				1 5		1 5		12 3			0 49	0 01	0 01	<0 010	<0 010	<0 010
04/22/93																	7 30			13 2				1 5		1 7		12 2			0 60	0 18	0 08	0 03	0 01	0 02
04/22/93																	7 30			13 2				6 0		2 0		12 2			0 97	0 29	0 14	0 07	0 04	0 02
04/26/93	3 07			0 100			70			0 18							7 29			13 5				3 5		1 6		12 3			0 40	0 08	0 01	<0 010	0 02	<0 010
04/26/93	3 07			0 100			70			0 18							7 29			13 5				32 0		4 0		12 2			1 80	1 52	1 32	1 03	0 85	0 72
04/27/93																	6 09			13 8				1 5		1 2		12 2			0 33	0 01	0 01	0 01	0 01	0 01
04/27/93																	6 10			13 8				1 5		1 6		12 3			0 51	0 12	0 03	<0 010	0 02	0 01
04/28/93										0 53							5 88			14 2				1 5		1 2		12 2			0 15	<0 010	<0 010	<0 010	<0 010	<0 010
04/28/93										0 19							6 09			14 2				1 5		1 2		12 2			0 17	<0 010	<0 010	<0 010	<0 010	<0 010
04/28/93										0 30							6 13			14 2				1 5		1 2		12 1			0 10	<0 010	<0 010	<0 010	<0 010	<0 010
04/28/93										0 46							5 90			14 2				1 5		1 2		12 1			0 15	<0 010	<0 010	<0 010	<0 010	<0 010
04/28/93										0 25							6 11			14 2				1 5		1 2		12 2			0 08	<0 010	<0 010	0 01	<0 010	<0 010
04/29/93										0 56						9 41	9 41			17 2				1 5		1 5		12 2			0 03	<0 010	<0 010	<0 010	<0 010	<0 010
04/29/93										0 22						9 37	9 37			17 2				1 5		1 5		12 2			0 03	<0 010	<0 010	<0 010	<0 010	<0 010
04/29/93										0 56						9 27	9 27			17 2				27 5		4 1		12 2			0 35	0 03	0 03	0 01	<0 010	0 01
05/03/93	3 18			0 108			77			0 56						8 30	8 30			16 3				9 0		1 5		12 2			0 33	0 04	0 03	0 03	0 03	0 03
05/03/93	3 18			0 108			77			0 56						8 30	8 30			16 3				12 0		1 7		12 2			0 46	0 03	0 02	0 02	0 02	0 02
05/03/93	3 18			0 108			77			0 44						8 30	8 30			16 3				14 5		2 0		12 2			0 50	0 02	0 02	0 02	0 02	0 02
05/03/93	3 18			0 108			77			0 57						8 30	8 30			16 3				22 5		2 3		12 2			0 72	0 13	0 02	0 01	0 02	0 01
05/04/93										0 47							6 06			16 0				8 0		2 0		12 2			1 07	0 40	0 21	0 13	0 08	0 05
05/12/93										0 33							6 07			16 0				1 5		1 0		12 1			0 15	<0 010	<0 010	<0 010	0 04	0 02
05/12/93										0 32							6 03			16 0				1 5		1 2		12 1			0 30	0 01	<0 010	0 01	0 01	<0 010
05/12/93										0 32							6 02			16 0				1 5		1 5		12 1			0 46	0 10	0 03	0 02	0 02	0 02
05/12/93										0 32							6 10			16 0				3 0		1 7		12 1			0 66	0 18	0 12	0 02	0 02	0 01
05/12/93										0 32							5 84			16 0				1 5		2 0		12 1			0 71	0 41	0 20	0 06	0 04	0 01
05/13/93										0 33						8 06	8 06			16 0				3 5		1 2		12 2			0 14	0 01	0 01	0 01	0 01	0 02
05/13/93										0 32						8 06	8 06			16 0				5 5		1 5		12 1			0 27	0 02	0 02	0 01	0 02	0 02
05/13/93										0 33						8 06	8 06			16 0				7 0		1 7		12 2			0 44	0 02	0 02	0 02	0 02	0 02
05/13/93										0 32						8 06	8 06			16 0				10 0		2 0		12 1			0 65	0 09	0 02	0 03	0 02	0 03
05/13/93										0 33						8 06	8 06			16 0				13 0		2 2		12 2			0 73	0 11	0 03	0 02	0 02	0 02
06/14/93							82			0 51						7 78	7 78			19 2				14 5		2 0		12 2			0 47	0 05	0 00	0 00	0 00	0 00
06/14/93	3 34	3 83					82			0 50						7 78	7 78			19 2				20 5		2 4		12 1			0 67	0 20	0 08	0 00	0 00	0 00
06/14/93							82			0 52						7 78	7 78			19 2				31 0		2 7		12 2			0 87	0 20	0 16	0 02	0 00	0 00
06/21/93	3 53						85			0 49						7 89	7 89			20 5				4 5		1 5		12 3			0 17	<0 010	<0 010	0 00	0 00	0 00
06/21/93	3 53						85			0 49						7 89	7 89			20 5				8 5		2 0		12 3			0 44	0 01	<0 010	0 00	0 00	0 00
06/21/93	3 53	3 75					85			0 48						7 89	7 89			20 5				19 0		2 5		12 2			0 63	0 13	0 04	0 00	0 00	0 00
06/28/93	3 59						84			0 54						7 87	7 87			20 8				12 8		1 5		12 2			0 17	0 02	0 01	0 00	0 00	0 00
06/28/93	3 59						84			0 50						7 87	7 87			20 8				6 0		2 0		12 2			0 44	0 02	0 01	0 00	0 00	0 00
06/28/93	3 59	3 78					84			0 53						7 87	7 87			20 8				23 5		2 5		12 2			0 55	0 14	0 09	0 02	0 00	0 00
07/06/93				0 116			88			0 51						7 93	7 93			21 7				4 5		1 5		12 2			0 16	0 01	0 00	0 00	0 00	0 00
07/06/93				0 116			88			0 48						7 93	7 93			21 7				9 0		2 0		12 2			0 36	0 02	0 02	0 00	0 00	0 00
07/06/93				0 116	0 058		88			0 49						7 93	7 93			21 7				18 5		2 4		12 3			0 39	0 06	0 02	0 00	0 00	0 00
07/28/93										0 53						8 07	8 07			21 2				13 0		2 0		12 3			0 42	0 03	0 04	0 00	0 00	0 00
07/28/93										0 50						8 07	8 07			21 2				12 5		2 0		6 1			0 45	0 11	0 05	0 00	0 00	0 00
07/28/93										0 52						8 07	8 07			21 2				12 0		2 1		17 9			0 24	0 03	0 03	0 00	0 00	0 00
07/19/94	3 38 (d)	3 18 (d)	3 02 (d)	0 087	0 062	0 047	80			0 21			1 55			8 13	8 13	7 80		23 2				1 5		1 8		6 5			0 43	0 04	0 03	0 00	0 00	0 00
07/25/94	3 18 (d)	3 11 (d)	2 75 (d)	0 091	0 065	0 041	80			0 22			1 1			8 26	8 26	7 87		23 4				9 0		1 7		6 5			0 52	0 09	0 06	0 00	0 00	0 00
08/01/94	3 43 (d)	3 30 (d)	2 95 (d)	0 091						0 22			1 3			8 14	8 14	7 71		23 7				6 0		2 0		6 8			0 75	0 13	0 19	0 00	0 00	0 00
08/16/94													0 9			8 10	8 25	7 65		24 6				3 0		1 4		6 5			0 35	0 11	0 11	0 03	0 00	0 00
08/17/94													1 4			8 70	8 15	6 25		24 9				1 5		1 4		6 5			0 46	0 23	0 17	0 08	0 00	0 00
08/17/94																8 70	7 15			24 9				5 0		1 5		6 4			0 39	0 10	0 10	0 03	0 00	0 00
08/18/94	3 52 (d)	3 52 (d)	2 87 (d)	0 084	0 058	0 041							1 6			8 56	7 15	7 14		24 8				4 0		1 5		6 5			0 46	0 14	0 13	0 04	0 00	0 00
08/29/94	3 58 (d)	3 68 (d)	2 89 (d)	0 093	0 059	0 042	82			0 22			0 9			8 65	7 56	7 30		24 2				1 5		1 4		8 5			0 35	0 06	0 05	0 00	0 00	0 00
10/24/94	3 10 (d)	3 17 (d)	2 74 (d)	0 089	0 050	0 036	77			0 26			0 74			7 93	7 92	7 70		18 8				11 0		1 7		8 5			0 55	0 23	0 22	0 10	0 00	0 00
10/26/94																7 94	7 00			18 8				3 0		1 0		6 4			0 20	0 05	0 06	0 02	0 00	0 00
10/26/94																7 94	7 06			18 8				7 5		1 5		6 5			0 53	0 25	0 28	0 23	0 10	0 05
10/26/94																7 90	7 90			18 8				7 0		1 5		6 5			0 45	0 20	0 11	0 01	0 00	0 00
10/26/94																7 94	7 06			18 8				13 0		2 0		6 4			0 95	0 58	0 51	0 36	0 32	0 24
10/26/94																7 91	7 91			18 8				15 5		2 0		6 5			0 88	0 31	0 28	0 14	0 09	0 04
10/26/94																7 94	7 94			18 8				26 0		2 5		6 5			1 06	0 83	0 57	0 33	0 27	0 18
10/27/94																	6 39			18 4				1 5		1 0		6 4			0 35	0 11	0 11	0 05	0 02	0 02
10/27/94																	6 38			18 4				1 5		1 3		6 4			0 60	0 30	0 29	0 17	0 13	0 09
10/27/94																	6 40			18 4				3 0		1 5		6 4			0 68	0 39	0 42	0 29	0 28	0 20
10/28/94																	5 90			18 3				1 5		1 0		6 4			0 42	0 14	0 14	0 07	0 05	0 04
10/28/94																	5 97			18 3				1 5		1 2		6 4			0 64	0 26	0 30	0 20	0 16	0 12
10/28/94																	5 90			18 3				1 5		1 5		6 4			0 89	0 44	0 47	0 35	0 29	0 23
10/31/94	3 02 (d)	2 76 (d)	2 17 (d)	0 083	0 048	0 036	78			0 29			0 75			8 01	7 83	7 62		18 2				10 0		1 5		6 5			0 52	0 23	0 19	0 07	0 00	0 00
11/01/94										0 40						7 96	6 96			18 2				4 0		1 0		6 4			0 42	0 17	0 15	0 07	0 06	0 04
11/01/94										0 35						7 96	6 82			18 2				8 5		1 5		6 4			0 90	0 62	0 46	0 26	0 23	0 18
11/01/94										0 40						7 96	7 96			18 2				14 0		1 5		6 4			0 68	0 33	0 25	0 10	0 08	0 02
11/01/94										0 41						7 96	6 82			18 2				11 0		2 0		6 4			1 11	1 21	0 78	0 63	0 53	0 42
11/01/94										0 40						7 99	7 99			18 2				26 0		2 0		6 4			0 87	0 48	0 45	0 29	0 21	0 13
11/01/94										0 40						7 96	7 96			18 2				36 0		2 5		6 4			1 38	0 80	0 74	0 52	0 46	0 33
11/02/94										0 43							6 43			17 8				1 5		1 0		6 4			0 31	0 10	0 08	0 04	0 02	0 01
11/02/94										0 38							6 05			17 8				1 5		1 0		6 4			0 34	0 12	0 12	0 05	0 04	<0 010

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Date	TOC (mg/L)			UV-254 (1/cm)			Alkalinity (mg/L as CaCO3)			Bromide (µg/L) (mg/L)			Turbidity (NTU)			pH (-)			Temperature (deg. C)			Bromate (µg/L)			Ozonation Conditions							
	Raw	Ozon.	Fin.	Raw	Ozon.	Fin.	Raw	Ozon.	Fin.	Raw	Ozon.	Fin.	Raw	Ozon.	Fin.	Raw	Ozon.	Fin.	Raw	Ozon.	Fin.	Raw	Ozon.	Fin.	Ozone dose (mg/L)	Ozone residual (mg/L)	Contact time (min) (full contactor)	Ozone pH (-)	Ozone temp. (deg. C)	Ozone residual (mg/L) Ch. 1A	Ozone residual (mg/L) Ch. 1B	Ozone residual (mg/L) Ch. 2A	Ozone residual (mg/L) Ch. 2B	Ozone residual (mg/L) Ch. 3A	Ozone residual (mg/L) Ch. 3B
11/02/94											0.42						6.41		17.8				4.0		1.2		6.4			0.53	0.34	0.29	0.18	0.13	0.09
11/02/94											0.41						6.05		17.6				4.0		1.3		6.4			0.51	0.29	0.28	0.18	0.14	0.09
11/02/94											0.41						6.41		17.8				5.0		1.5		6.4			0.60	0.31	0.36	0.27	0.23	0.18
11/02/94											0.42						6.05		17.8				3.5		1.5		6.4			0.82	0.48	0.50	0.33	0.30	0.23
11/07/94	2.78 (d)	2.81 (d)	2.29 (d)	0.080	0.048	0.033	78				0.28		0.7			7.97	7.97	7.63	16.4				15.0		1.7		6.5			0.76	0.49	0.36	0.20	0.00	0.00
11/08/94											0.53					7.90	6.92		18.2				6.0		1.0		6.4			0.43	0.19	0.18	0.09	0.07	0.03
11/08/94											0.55					7.90	7.90		18.2				12.5		1.2		6.4			0.52	0.17	0.19	0.08	0.05	0.04
11/08/94											0.54					7.90	6.87		18.2				9.5		1.5		6.4			0.89	0.58	0.55	0.40	0.35	0.31
11/08/94											0.56					7.90	7.90		16.2				21.0		1.5		6.4			0.70	0.37	0.33	0.17	0.11	0.07
11/08/94											0.55					7.90	6.87		16.2				12.0		2.0		6.4			1.23	0.84	0.88	0.74	0.65	0.58
11/08/94											0.54					7.90	7.90		16.2				34.5		2.0		6.4			0.96	0.55	0.57	0.45	0.37	0.29
11/10/94											0.54						6.44		15.9				3.0		1.0		6.4			0.39	0.14	0.15	0.08	0.06	0.02
11/10/94											0.54						6.06		15.9				1.5		1.0		6.4			0.40	0.18	0.21	0.11	0.10	0.05
11/10/94											0.54						6.10		15.9				3.0		1.2		6.4			0.46	0.33	0.32	0.24	0.21	0.17
11/10/94											0.53						6.44		15.9				5.0		1.3		6.4			0.80	0.37	0.33	0.22	0.17	0.12
11/10/94											0.53						6.05		15.9				4.0		1.5		6.4			0.89	0.46	0.52	0.41	0.36	0.31
11/10/94											0.56						6.44		15.9				5.0		1.5		6.4			0.77	0.48	0.52	0.36	0.33	0.28
11/14/94	2.78 (d)	2.89 (d)	2.39 (d)	0.080	0.048	0.033	75				0.29		0.64			8.31	8.29	7.95	15.1				8.0		1.5		6.5			0.54	0.13	0.18	0.06	0.00	0.00
11/29/94	2.74 (d)	2.82 (d)	2.39 (d)				80				0.30		1.05			8.33	8.37	7.70	12.7				7.0		1.5		6.4			0.51	0.23	0.21	0.06	0.00	0.00
12/06/94	2.61 (d)	2.66 (d)	2.22 (d)								0.33		1.5			8.02	8.03	7.63	11.3				10.0		1.3		6.5			0.62	0.31	0.30	0.15	0.12	0.07
12/14/94													1.9			8.06	8.06	7.70	11.9				9.0		1.2		6.5			0.56	0.32	0.26	0.15	0.10	0.07
12/20/94	2.67 (d)	2.73 (d)	2.36 (d)	0.078	0.045	0.036	82						1.2			8.06	8.06	7.78	10.1				9.0		1.2		6.4			0.62	0.35	0.27	0.15	0.12	0.08
12/26/94	2.65 (d)	2.65 (d)	2.41 (d)	0.078	0.053	0.036	82				0.34		1.1			8.11	8.11	7.97	9.8				7.0		1.2		6.5			0.46	0.30	0.27	0.15	0.12	0.07
01/05/95	2.48 (d)	2.56 (d)	2.08 (d)	0.077	0.047	0.031							0.85			8.15	8.15	7.78	10.0				6.0		1.2		6.4			0.44	0.25	0.23	0.14	0.10	0.05
01/10/95	2.42 (d)	2.46 (d)	2.15 (d)	0.079	0.050	0.032	79				0.31		1.4			8.22	8.22	7.83	10.4				8.0		1.2		6.4			0.54	0.23	0.23	0.13	0.08	0.05
01/18/95	2.46 (d)	2.49 (d)	2.10 (d)	0.073	0.047	0.035	79				0.31		2.2			8.07	8.07	7.71	10.2				8.0		1.2		6.5			0.49	0.21	0.24	0.10	0.06	0.04
01/24/95	2.73 (d)	2.70 (d)	2.32 (d)	0.076	0.045	0.033	79				0.31		1.3			8.12	8.12	7.78	10.3				8.0		1.3		6.5			0.56	0.28	0.25	0.11	0.09	0.05
01/31/95	2.58 (d)	2.58 (d)	2.22 (d)	0.072	0.041	0.032	78				0.29		0.77			8.51	8.51	8.00	11.1				8.0		1.5		6.5			0.54	0.22	0.22	0.09	0.05	0.01
02/01/95	2.23						78				0.50					8.56	7.66		11.7				14.0		1.6		6.5			0.78	0.43	0.46	0.36	0.30	0.23
02/02/95	2.50										0.50					8.36	7.89		11.3				21.5		2.0		6.5			1.25	0.70	0.74	0.58	0.52	0.43
02/07/95	2.76 (d)	2.83 (d)	2.36 (d)	0.082	0.047	0.035	79				0.26		0.85			8.28	8.28	7.78	11.8				12.0		1.6		6.5			0.58	0.28	0.27	0.13	0.09	0.03
02/14/95	2.82 (d)	2.89 (d)	2.61 (d)	0.085	0.048	0.036	80				0.28		0.9			8.37	8.37	8.00	11.4				12.0		1.8		6.4			0.88	0.29	0.28	0.14	0.08	0.03
02/28/95	3.12 (d)	3.31 (d)	2.68 (d)	0.089	0.056	0.038					0.27		1.6			8.89	7.78	7.58	12.9				8.0		1.8		6.5			0.47	0.19	0.18	0.07	0.03	< 0.01
08/13/95	3.37			0.110			88			0.14			4.2			8.59	8.58		19.4				4.0		3.0		6.5			0.70	0.15	0.07	0.03	0.02	0.02
08/14/95	3.27			0.104			88			0.14	0.34		3.5			8.52	8.52		19.4				21.0		3.3		6.5			0.85	0.19	0.18	0.01	0.01	0.01
08/15/95	3.40			0.108			88				0.40		5.8			8.52	7.43		19.4				18.0		3.0		6.5			0.72	0.47	0.46	0.26	0.18	0.08

D—042266

Utility ID:	SCVWD	(ACWD, CCWD, EBMUD, MWD, SCVWD)
1. Study ID:	Pilot Study 93-94	(Optimization Study 9/95, etc.)
2. Source water:	South Bay Aquaduct	(River, lake, groundwater, etc.)
3. Source water ID:	State Project Water	(State Project water, blend of...., etc.)

5. Describe level of study: (indicate with an 'X')		Bench-scale
	X	Pilot-scale
		Full-scale

In this data sheet, "Filt." refers to data collected after coagulation, flocculation, sedimentation, and filtration.

4. If blended source water indicate sources and proportions:

Source	%

6. Indicate with an 'X' if data reported as "Filt." are from samples collected after sedimentation only: ☐

or after sedimentation and filtration: ☒

WATER QUALITY DATA: CONVENTIONAL

Date	TOC		UV-254		Alkalinity		Hardness				Bromide		Chloride		TDS		Turbidity		pH		Temperature	
	(mg/L)		(1/cm)		(mg/L as CaCO3)		(mg/L as CaCO3)				(µg/L)		(mg Cl-/L)		(mg/L)		(NTU)		()		(deg. C)	
	Raw	Filt.	Raw	Filt.	Raw	Filt.	Total		Calcium		Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.
							Raw	Filt.	Raw	Filt.												
11/3/93	3.46	2.48	0.127	0.0532	83	81	117	117			170		61		232	237	2.9	0.071	8.1	7.98	18.7	21
11/4/93	3.32	2.14	0.113	0.0346	85	70	122	122			150		57		230	234	2.09	0.054	7.58	6.96	18.7	20.9
11/16/93	2.81	1.52	0.112	0.0238	60	8	103	103			230		75		235	253	7.19	0.096	7.48	5.52	16.8	17.5
11/17/93	3.05	0.78	0.118	0.011	62	21	105	105			220		71		238	255	10.13	3.17	7.42	5.53	16.4	18.1
11/18/93	2.94	0.92	0.114	0.013	70	26	105	105			220		74		241	251	4.68	0.048	7.24	6.24	17.5	18.2
11/3/93	3.46	2.46	0.127	0.049	83	67	117	117			170		61		232	240	2.9	0.066	7.6	6.8	18.7	21
11/3/93	3.46	1.22	0.127	0.023	83	66	117	117			170		61		232	242	2.9	0.06	7.6	6.49	18.7	21.3
11/4/93	3.32	2.16	0.113	0.039	85	68	122	122			150		57		230	240	2.09	0.063	7.58	7	18.7	20
11/4/93	3.32	0.7	0.113	0.010	85	39	122	122			150		57		230	250	2.09	0.041	7.58	6.44	18.7	21.3
11/15/93	2.96	1.05	0.123	0.016	71	12	108	108			170		72		237	260	4.76	0.046	7.75	5.49	17.7	18.7
11/15/93	2.96	1.63	0.123	0.026	71	13	108	108			170		72		237	253	4.76	0.096	7.75	5.52	17.7	17.5
11/16/93	2.81	0.94	0.112	0.016	60	7	103	103			230		75		235	257	7.19	0.051	7.48	5.58	16.8	17.8
2/15/94	4.82	2.74	0.215	0.057	83	55	115	115			160				219	234	7.37	0.101	7.59	6.4	12.5	13.3
4/25/94	4.6	2.57	0.181	0.046	81	56	124	124			550	290	70		272	283	5.94	0.07	7.87	6.71	16.9	17.2
4/27/94	4.67	2.49	0.168	0.041	82	57	127	127			530		73		274	291	7.97	0.067	7.64	6.78	17.1	17.9
4/28/94	4.58	2.4	0.193	0.040	81	59	126	126			550		74		280	293	8.69	0.09	7.5	6.77	18	18.3
5/2/94	4.56	2.53	0.161	0.041	81	60	127	127			560		72		281	292	5.34	0.085	8.13	6.71	17.6	17.9
5/16/94	3.97	2.57	0.142	0.053	95	80	129	129			450		50		241	246	5.57	0.104	8.04	7.06	16.2	18.1
5/16/94	3.97	2.57	0.142	0.053	95	80	129	129			450		50		241	246	5.57	0.104	8.04	7.06	16.2	18.1
5/16/94	3.97	2.57	0.142	0.053	95	80	129	129			450		50		241	246	5.57	0.104	8.04	7.06	16.2	18.1
5/16/94	3.97	2.57	0.142	0.053	95	80	129	129			450		50		241	246	5.57	0.104	8.04	7.06	16.2	18.1
5/17/94	3.79	2.68	0.155	0.056	81	69	120	120			530		69		266	259	4.92	0.087	8.71	7.28	18.5	18.5
5/19/94	3.86	2.57	0.141	0.050	85	71	120	120			600		69		261	273	5.4	0.063	8.56	7.06	18.5	18.9
5/24/94	3.89	2.73	0.136	0.050	89	82	128	128			670		54		236	242	6.84	0.083	8.12	6.99	16.8	20
3/1/94	5.57	2.31	0.262	0.045	70	53	113	113			170	120			235	250	9.66	0.099	7.6	6.23	14.5	15.8
3/1/94	5.57	2.31	0.262	0.045	70	53	113	113			170	120			235	250	9.66	0.099	7.6	6.23	14.5	15.8
3/1/94	5.57	2.31	0.262	0.045	70	53	113	113			170	120			235	250	9.66	0.099	7.6	6.23	14.5	15.8
3/1/94	5.57	2.31	0.262	0.045	70	53	113	113			170	120			235	250	9.66	0.099	7.6	6.23	14.5	15.8
6/13/94	3.2	2.08	0.121	0.048	77	68	115	115			560		71		263	268	4.5	0.072	8.1	7.16	19	20.2
6/14/94	3.22	2.46	0.114	0.054	78	65	117	117			600				263	276	4.53	0.117	8.29	7.32	19.9	21.2
6/15/94	3.25	2.6	0.118	0.059	78	75	113	113			600	290	73		267	275	4.88	0.098	8.2	7.45	18.2	20.1
6/16/94	3.15	1.67	0.118	0.027	79	43	114	114			1000	560	73		266	282	4.25	0.073	7.96	6.55	17.3	19.7

Utility ID:																						
1. Study ID:																						
2. Source wa																						
3. Source wa																						
5. Describe l																						
(indicate wit																						
6. Indicate w																						
WATER Q																						

Indicate coagulants studied:

ID	coagulan	Chemical formula	Units
1	Alum	Al2(SO4)3	mg/L
2	erric Chl	FeCl3	mg/L
3			
4			

TREATMENT CONDITIONS

Date	Chlorination conditions									Disinfection By-products						Coagulation Conditions					
	Filtered									TTHM (µg/L)		HAA5 (µg/L)		HAA6 (µg/L)		Coagulant ID	Dose	Acid adjusted?	Base adjusted?	Coag. pH	Coag. temp.
	Indicate disinfectant(s) used with an 'X'		Chlorine dose	Ammonia dose	Incububation time (h)		Incub. temp.	pH	Residual FREE	Raw	Filt.	Raw	Filt.	Raw	Filt.	(see above)		(Y/N)	(Y/N)	()	(deg. C)
	chlorine	chloramine	(mg Cl2/L)	(mg NH3-N/L)	chlorine	chloramine	(deg. C)	()	(mg Cl2/L)												
11/3/93	X	X	2.4	0.56	0.25	72	20 to 25	7.98	1.68		38		25.7		29.6	1	20	N	N	7.98	20
11/4/93	X	X	2.4	0.60	0.25	72	20 to 25	8.05	1.8		31		25.4		29.3	1	28	N	N	6.96	19.4
11/16/93	X	X	2.4	0.33	0.25	72	20 to 25	8.02	1		23		22.5		25.9	1	40	Y	N	5.52	17.1
11/17/93	X	X	2.4	0.39	0.25	72	20 to 25	8.05	1.17		14		18.5		20	1	40	Y	N	5.53	18.8
11/18/93	X	X	2.4	0.35	0.25	72	20 to 25	8.05	1.05		14		18.5		20	1	40	Y	N	6.24	18.6
11/3/93	X	X	2.3	0.69	0.17	72	20 to 25	6.8	2.07		34		24.7		29.3	2	15	N	N	6.73	19.6
11/3/93	X	X	2.3	0.57	0.17	72	20 to 25	6.6	1.72		21		13.5		15	2	15	N	N	6.59	20.3
11/4/93	X	X		0.55	0.17	72	20 to 25	7	1.65		35		19.7		23.8	2	15	N	N	7.06	19.5
11/4/93	X	X		0.69	0.17	72	20 to 25	6.48	2.07		11		13.5		15	2	45	N	N	6.3	19.3
11/15/93	X	X		0.36	0.25	72	20 to 25	5.61	1.07		18		15.4		16.9	2	30	Y	N	5.48	18.9
11/15/93	X	X		0.35	0.25	72	20 to 25	5.68	1.05		23		18.5		20.3	2	40	Y	N	5.49	18.6
11/16/93	X	X		0.35	0.25	72	20 to 25	5.67	1.05		20		13.5		15	2	30	Y	N	5.5	17.2
2/15/94	X	X	2	0.67	0.08	72	20 to 25	6.4	2		45		33.2		39.2	2	37	N	N	6.3	12.9
4/25/94	X	X	2	0.39	0.25	72	20 to 25	6.71	1.16		66		18.8		20.3	2	22	N	N	6.66	17.5
4/27/94	X	X	2	0.32	0.50	72	20 to 25	6.78	0.97		74		20.4		23.7	2	23	N	N	6.77	17.1
4/28/94	X	X	2	0.33	0.50	72	20 to 25	6.77	1		78		18.8		22.1	2	23	N	N	6.84	16.5
5/2/94	X	X	2	0.33	0.50	72	20 to 25	6.71	0.99		79		23		24.5	2	23	N	N	6.76	17.4
5/16/94	X	X	2	0.33	0.25	72	20 to 25	7.06	1		62		23		26.6	2	23	N	N	7.06	17.3
5/16/94	X	X	2	0.31	0.50	72	20 to 25	7.06	0.93		70		23		26.6	2	23	N	N	7.06	17.3
5/16/94	X	X	2	0.18	1.00	72	20 to 25	7.06	0.54		75		23		26.6	2	23	N	N	7.06	17.3
5/16/94	X	X	2	0.10	2.00	72	20 to 25	7.06	0.3		80		25		28.7	2	23	N	N	7.06	17.3
5/17/94	X	X	2	0.27	0.50	72	20 to 25	7.28	0.82		96		21.3		25.1	2	23	N	N	7.39	18.9
5/19/94	X	X	2	0.28	0.50	72	20 to 25	7.06	0.85		95		24		25.5	2	23	N	N	7.14	18.7
5/24/94	X	X	2	0.24	0.50	72	20 to 25	6.99	0.72		73		20.4		24.5	2	26	N	N	6.99	19.9
3/1/94	X	X	2	0.38	0.25	72	20 to 25	6.23	1.15		43		13.5		15	2	43	N	N	6.54	15.1
3/1/94	X	X	2	0.33	0.50	72	20 to 25	6.23	1		38		15.2		19.1	2	43	N	N	6.54	15.1
3/1/94	X	X	2	0.27	1.00	72	20 to 25	6.23	0.8		38		15.2		18.7	2	43	N	N	6.54	15.1
3/1/94	X	X	2	0.22	2.00	72	20 to 25	6.23	0.65		39		18		22.3	2	43	N	N	6.54	15.1
6/13/94	X	X	2	0.30	0.25	72	20 to 25	7.16	0.89		55		25		30	2	30	N	N	7.07	19.7
6/14/94	X	X	2	0.29	0.50	72	20 to 25	7.32	0.87				31.3		40.7	2	30	N	N	7.37	20.5
6/15/94	X	X	2	0.25	0.50	72	20 to 25	7.45	0.74				28		35.3	2	30	N	N	7.16	19.6
6/16/94	X	X	2	0.17	0.50	72	20 to 25	6.55	0.51				83.9		93.7	2	32	N	N	6.62	19.6

Utility ID:	SCVWD	(ACWD, CCWD, EBMUD, MWD, SCVWD)	
1. Study ID:	Pilot Study 93-94	(Optimization Study 9/95, etc.)	
2. Source water:	South Bay Aquaduct - San luis Reservoir	(River, lake, groundwater, etc.)	
3. Source water ID:	State and Federal Water Projects	(State Project water, blend of...., etc.)	
5. Describe level of study: (indicate with an 'X')			Bench-scale
		X	Pilot-scale
			Full-scale

WATER QUALITY DATA: CONVENTIONAL+OZONE

Date	Time	TOC (mg/L) Raw	TOC Settl.	TOC Ozon.	TOC Filt.	UV-254 (1/cm) Raw	UV-254 Settl.	UV-254 Ozon.	UV-254 Filt.	Alkalinity (mg/L as CaCO3) Raw	Alkalinity Settl.	Alkalinity Ozon.	Alkalinity Filt.	Hardness (mg/L as CaCO3) Total Raw	Hardness Total Settl.	Hardness Total Ozon.	Hardness Total Filt.
5/11/93		3.51	2.59		2					68	44			110	110		
5/18/93		3.58	2.37		1.64	0.027	0.034			62	49		41	105	110		107
5/25/93		5.86	3.09		2.17	0.041				79	58		52	130	130		130
2/15/94		4.82	2.66		1.73	0.215	0.293		0.026	83	50		57	115	115		115
3/1/94		5.57	2.99		2.27	0.262	0.023		0.029	70	44		43	113	113		113
3/14/94		3.09	2.18		1.67	0.114			0.023	70	53		56	107	107		107
4/25/94		4.6	3.06		2.32	0.181	0.209		0.033	81	59		59	124	124		124
4/25/94		4.6	3.06		1.55	0.181	0.209		0.023	81	59		56	124	124		124
5/16/94		3.97	3		2.24	0.142	0.218		0.031	95	79		79	129	129		129
5/16/94		3.97	3		1.85	0.142	0.218		0.025	95			74	129			129
6/13/94		3.2	2.17		1.69	0.121	0.123		0.026	77	59		58	115	115		115
6/13/94		3.2	2.17		1.32	0.121	0.123		0.021	77	59		56	115	115		115
	Bromate Data																
5/11/93		3.51	2.59		2					68	44			110	110		
5/18/93		3.58	2.37		1.64	0.027	0.034			62	49		41	105	110		107
5/25/93		5.86	3.09		2.17	0.041				79	58		52	130	130		130
5/26/93		6.56	3.19			0.043				79	68		6.5	131			
8/18/93		2.78	1.33			0.136	0.146			45	15			45			
8/25/93		4.13								38	17			38	36		
8/26/93		2.34	1.06			0.128	0.115			40	18		17	41	41		
9/1/93		2.52	1.2			0.128	0.151			43	12		15	48	48		
10/4/93		3.62	2.23			0.107	0.146			87	59		57	105	105		105
10/5/93		3.58	2.69			0.109	0.180			95	56		70	110	110		110
10/6/93		3.6	1.97			0.098	0.147			92	61		51	109	109		109
10/7/93		3.48	2.37			0.102	0.160			93	68		64	102	102		102
10/7/93		3.48				0.102				93	68		64	102	102		102
10/12/93		3.67				0.106				96	79		62	116	116		116
10/12/93		3.67	3.03			0.106	0.182			96	79		62	116	116		116
10/13/93		3.42	3.89			0.096	0.256			96	82		33	112	112		112
10/13/93		3.42	3.89			0.096	0.256			96	82		33	112	112		112
10/14/93		5.02	4.02			0.150	0.273			65	65		56	107	107		107
10/14/93		5.02	2.84			0.150	0.174			65	51		29	107	107		107
10/14/93		5.02				0.150				65	51		29	107	107		107
1/27/94										71	46		50	112	112		112
2/15/94		4.82	2.66		1.73	0.215	0.293			83	50		57	115	115		115
3/1/94		5.57	2.99		2.27	0.262	0.023			70	44		43	113	113		113
3/14/94		3.09	2.18		1.67	0.114				70	53		56	107	107		107
4/25/94		4.6	3.06		2.32	0.181	0.209			81	59		59	124	124		124
4/27/94		4.67	3.08			0.168	0.226			82	61		60	127	127		127
4/28/94		4.58	3.09			0.193	0.217			81	63		61	126	126		126
5/2/94		4.56	3.06			0.161	0.224			81	58		62	127	126		127
5/16/94		3.97	3		2.24	0.142	0.218			95	79		79	129	129		129
5/17/94		3.79	2.96			0.155	0.210			81	66		68	120	120		120
5/19/94		3.86	2.79			0.141	0.190			85	71		70	120	120		120
5/24/94		3.89	2.73			0.136	0.232			89	71		78	128	128		128
6/13/94		3.2	2.17		1.69	0.121	0.123			77	59		58	115	115		115
6/14/94		3.22	2.06			0.114	0.101			78	58		58	117	117		117
6/15/94		3.25	2.24			0.118	0.116			78	62		58	113	113		113
6/16/94		3.15	2.19			0.118	0.157			79	60		61	114	114		114

Date	Time	Bromide (µg/L) Raw	Bromide Settl.	Bromide Ozon.	Bromide Filt.	Ammonia (mg NH3-N/L) Raw	Ammonia Settl.	Ammonia Ozon.	Ammonia Filt.	Chloride (mg Cl-/L) Raw	Chloride Settl.	Chloride Ozon.	Chloride Filt.	TDS (mg/L) Raw	TDS Settl.	TDS Ozon.	TDS Filt.	Raw
5/11/93		170			110									236	254			11
5/18/93		160			140									234	233		220	10
5/25/93		230			190									270	282		290	6
2/15/94		160			100									219	230		233	7.37
3/1/94		170			140									235	248		242	9.66
3/14/94		200			130									243	245		249	1.429
4/25/94		550		550	370					70				272	283		284	5.94
4/25/94		550		550	320					70				272	283		284	5.94
5/16/94		450		480	320					50				241	245		246	5.57
5/16/94		450		480	330					50				241			246	5.57
6/13/94		560		360	390					71				263	267		269	4.5
6/13/94		560		360	370					71				263	267		269	4.5
	Bromate Data																	
5/11/93		170			110									236				11
5/18/93		160			140									234			220	10
5/25/93		230			190									270			290	6
5/26/93		220												285			290	6
8/18/93										16				88.6			51	21
8/25/93		170								32				48.8				15
8/26/93										16				52.7			69	13
9/1/93		50	740							16				58.2			78	22.8
10/4/93		80	200				0.5			30				168			179	7.16
10/5/93		80	580				0.5			31				173			182	7.2
10/6/93		90					0.5			32				180			197	9.73
10/7/93		90	460				0.5			33				177			191	9.79
10/7/93		90	460				0.5			33				177			191	9.79
10/12/93		90	250				0.5			32				178			200	5.42
10/12/93		90	250				0.5			32				178			200	5.42
10/13/93		90	730				0.5			32				179			220	5.68
10/13/93		90	730				0.5			32				179			220	5.68
10/14/93		120	720							62				228			217	3.4
10/14/93		120	720							62				228			233	3.4
10/14/93		120	720							62				228			233	3.4
1/27/94		200												241			251	11.07
2/15/94		160			100									219			233	7.37
3/1/94		170			140									235			242	9.66
3/14/94		200			130									243			249	1.429
4/25/94		210	550		370					70				272			284	5.94
4/27/94		190	530		520					73				274			288	7.97
4/28/94		190	550		490					74				280			285	8.69
5/2/94		200	560		550					72				281			290	5.34
5/16/94		180	450		3					50				241			246	5.57
5/17/94		180	530		320					69				266			277	4.92
5/19/94		180	500							69				261			274	5.4
5/24/94		180	670		510					54				236			247	6.84
6/13/94		200	560		390					71				263			269	4.5
6/14/94		180	600		570									263			277	4.53
6/15/94		220	600		600					73				267			273	4.88
6/16/94		200	1000		1000					73				266			273	4.25

D-042269

Utility ID:

1. Study I

2. Source

3. Source

WATER

Date	Turbidity (NTU)			pH ()				Temperature (deg. C)				Bromate (µg/L)				Bacteria HPC (CFU/mL)				Chlorination conditions Filtered									T (µ
	Settl.	Ozon.	Filt.	Raw	Settl.	Ozon.	Filt.	Raw	Settl.	Ozon.	Filt.	Raw	Settl.	Ozon.	Filt.	Raw	Settl.	Ozon.	Filt.	Indicate disinfectant(s) used with an 'X' chlorine	Indicate disinfectant(s) used with an 'X' chloramine	Chlorine dose (mg Cl2/L)	Ammonia dose (mg NH3-N/L)	Incubation time (h) chlorine	Incubation time (h) chloramine	Incub. temp. (deg. C)	pH ()	Residual (mg Cl2/L)	Raw	Settl.
5/11/93	2		0.08	7.8	6.43	6.43		20	19.2			2			1				3933	X	X	2.5	0.73	0.083	168	20-25	6.6	2.18		
5/18/93	1.7		0.1	7.8	6.56	6.56	6.56	21	21.5		21.8	11.5							108	X	X	2.5	0.66	0.083	168	20-26	6.68	1.97		
5/25/93	3			6.8	6.33	6.33		18.7	17.8			16.5			13.5				3100	X	X	2.5	0.73	0.083	168	20-27	6.41	2.2		
2/15/94	2.32		0.164	7.59	6.24	6.24	6.34	12.5	12.8		14.8	1			2	820			1900	X	X	2	0.49	0.083	168	20-28	6.34	1.46		
3/1/94	3.05		0.077	7.6	6.4	6.4	6.52	14.5	14.1		16.6	1			2	2100			1300	X	X	2	0.45	0.083	168	20-29	6.52	1.35		
3/14/94	1.499		0.087	7.28	6.76	6.76	6.58	12.9	14.2		18	2.2			2.6				2800	X	X	2	0.56	0.083	168	20-30	6.58	1.67		
4/25/94	2.02		0.05	7.87	6.69	6.69	6.92	16.9	17.2		17.9	2			2	81			570	X	X	2	0.50	0.083	168	20-31	6.92	1.49		
4/25/94	2.02		0.053	7.87	6.69	6.69	6.79	16.9	17.2		18.2	2			2	81			2100	X	X	2	0.47	0.083	168	20-32	6.79	1.42		
5/16/94	2.14		0.066	8.04	7.04	7.04	6.98	16.2	17.7		18.6	2.4			2.9	1500			1300	X	X	2	0.53	0.083	168	20-33	6.98	1.59		
5/16/94	2.14		0.067	8.04	7.04	7.04	6.9	16.2	17.7		18.4	2.4			2	1500			3100	X	X	2	0.51	0.083	168	20-34	6.9	1.52		
6/13/94	1.14		0.041	8.1	6.8	6.8	6.87	19	19.5		20.8	3.5			3.2	690			860	X	X	2	0.47	0.083	168	20-35	6.87	1.41		
6/13/94	1.14		0.029	8.1	6.8	6.8	6.97	19	19.5		21	3.5			2.4	690			3100	X	X	2	0.47	0.083	168	20-36	6.97	1.42		
5/11/93	2		0.08	7.8	6.43	6.43		20	19.2		-			2	1															
5/18/93	1.7		0.1	7.8	6.56	6.56	6.56	21	21.5		21.8			11.5																
5/25/93	3			6.8	6.33	6.33		18.7	17.8					16.5	13.5															
5/26/93	4.2		0.26	6.8	6.8	6.8	6.49	17.3	16.7		18			23																
8/18/93	2		0.097	7.4	6.103	6.103	6.21	22.9	23.9		25.8				1															
8/25/93	1.7		0.05	7.3	6.11	6.11		23	25.3						2.2															
8/26/93	1.5		0.1	7.6	6.21	6.21	6.35	22.5	26.3		27.4				4.1															
9/1/93	2		0.02	7.47	5.93	5.93	6.06	23.7	25		26.5				1															
10/4/93	1.27		0.04	7.74	6.52	6.52	6.44	19	19.5		20.5				1															
10/5/93	1.14		0.058	7.81	6.62	6.62	7	18.2	18.6		18.9				4.2															
10/6/93	1.28		0.083	7.81	6.77	6.77	6.64	17.7	17.8		19.7				4.7															
10/7/93	1.81		0.058	7.94	6.89	6.89	6.9	18.4	19.3		22				4.7															
10/7/93	1.81		0.058	7.94	6.89	6.89	6.9	18.4	19.3		22				4.3															
10/12/93	2.9		0.065	7.6	6.98	6.98	6.75	18.5	19		20.9				12.4															
10/12/93	2.9		0.065	7.6	6.98	6.98	6.75	18.5	19		20.9				1															
10/13/93	2.18		0.128	7.93	7.16	7.16	6.1	18.6	19.4		20				1															
10/13/93	2.18		0.128	7.93	7.16	7.16	6.1	18.6	19.4		20				1															
10/14/93	3.4		0.26	7	7	7	6.53	19	19		20.3				9.1															
10/14/93	1.34		0.09	7	6.67	6.67	6.15	19	19.2		20.2				6.4															
10/14/93	1.34		0.09	7	6.67	6.67	6.15	19	19.2		20.2				2.7															
1/27/94	3.36		0.415	7.15	6.28	6.28	6.33	11.9	13		15.4				2															
2/15/94	2.32		0.164	7.59	6.24	6.24	6.34	12.5	12.8		14.8			1	2															
3/1/94	3.05		0.077	7.6	6.4	6.4	6.52	14.5	14.1		16.6			1	2															
3/14/94	1.499		0.087	7.28	6.76	6.76	6.58	12.9	14.2		18			2.2	2.6															
4/25/94	2.02		0.05	7.87	6.69	6.69	6.92	16.9	17.2		17.9			2	2															
4/27/94	2.73		0.058	7.64	6.89	6.89	6.89	17.1	17.1		18.5			2	2															
4/28/94	2.72		0.071	7.5	6.91	6.91	6.84	16	16.8		18.3			2	2															
5/2/94	1.89		0.074	8.13	6.74	6.74	6.8	17.6	17.4		18.5			2	2															
5/16/94	2.14		0.066	8.04	7.04	7.04	6.98	16.2	17.7		18.6			2.4	2.9															
5/17/94	1.79		0.054	8.71	7.16	7.16	7.12	16.5	18.9		19.6			2.7	2.8															
5/19/94	2.16		0.058	8.56	7.12	7.12	6.99	18.5	18.4		19.7			2.1	2.1															
5/24/94	2.04		0.056	8.12	6.83	6.83	6.87	16.8	19.3		20.9			2	2															
6/13/94	1.14		0.041	8.1	6.8	6.8	6.87	19	19.5		20.8			3.5	3.2															
6/14/94	1.94		0.044	8.29	7	7	6.92	19.9	20.1		21.9			4	3.2															
6/15/94	0.97		0.037	8.2	6.79	6.79	7.04	18.2	19.8		20.5			2.2	2.1															
6/16/94	1.58		0.032	7.98	6.93	6.93	6.97	17.3	18.8		20.4			2.9	2.5															

Utility ID:

1. Study I

2. Source

3. Source

Indicate coagulants studied:

ID	Coagulant	Chemical formula	Units
1	Alum	Al2(SO4)3	mg/L
2	Ferric Chlo.	FeCl3	mg/L
3			
4			

WATER

TREATMENT CONDITIONS

Date	Disinfection By-products														Coagulation Conditions						Ozonation Conditions				
	M		HAA5 (µg/L)				HAA6 (µg/L)				TOX (µg Cl-/L)				Coagulant	Dose	Acid	Base	Coag.	Coag.	Ozone	Ozone	Contact	Ozone	Ozone
	/L)														ID		adjusted?	adjusted?	pH	temp.	dose	residual	time	pH	temp.
	Ozon.	Filt.	Raw	Settl.	Ozon.	Filt.	Raw	Settl.	Ozon.	Filt.	Raw	Settl.	Ozon.	Filt.	(see above)		(Y/N)	(Y/N)	()	(deg. C)	(mg/L)	(mg/L)	(min)	()	(deg. C)
5/11/93		12				60.3				61.8					2	20	N		6.43	19.2	1.6	0.7	12	6.4	19.2
5/18/93		7				16				17.5					2	20	N		6.56	21.5	2.1	1.3	12	6.56	21.5
5/25/93		11				25				37					2	30	N		6.33	17.8	3.4	1.33	12	6.22	19.7
2/15/94		23				15.2				16.7					2	30	N		6.24	12.8	1.2	0.28	12	6.24	13.3
3/1/94		20				13.5				15					2	30	N		6.4	14.1	0.9	0.12	12	6.36	15.7
3/14/94		14				13.5				15					2	22	N		6.76	14.2	0.9	0.15	12	6.51	18.5
4/25/94		48				17.4				18.9					2	20	N		6.69	17.2	0.7	0.15	12	6.7	17.3
4/25/94		30				15.2				16.7					2	20	N		6.69	17.2	0.7	0.15	12	6.7	17.3
5/16/94		30				17.9				19.4					2	20	N		7.04	17.7	0.9	0.18	12	7.04	17.7
5/16/94		29				15.9				17.4					2	20	N		7.04	17.7	0.9	0.18	12	7.04	17.7
6/13/94		28				17.4				18.9					2	20	N		6.8	19.5	0.9	0.18	12	6.91	19.6
6/13/94		42				15.7				17.2					2	20			6.8	19.5	0.9	0.18	12	6.91	19.6
5/11/93																					1.6	0.7	12	6.4	19.2
5/18/93																					2.1	1.3	12	6.56	21.5
5/25/93																					3.4	1.33	12	6.22	19.7
5/26/93																					4	1.06	12	6.8	16.7
8/18/93																					0.7	0.16	12	6.21	25.8
8/25/93																					1.6	0.27	12	6.3	23
8/26/93																					2.7	1.13	12	6.1	26.8
9/1/93																					0.8	0.26	12	5.96	25.1
10/4/93																					0.8	0.22	12	6.48	19.6
10/5/93																					1.7	0.74	12		
10/6/93																					2.7	1.65	12		
10/7/93																					0.8	0.16	12	6.9	20
10/7/93																					1.7	0.83	12		
10/12/93																					2.7	1.35	12	6.99	19.8
10/12/93																					0.7	0.2	12		
10/13/93																					1.6	0.78	12	6.05	19.7
10/13/93																					2.6	1.31	12	5.98	19.3
10/14/93																					2.2	0.63	12		
10/14/93																					2.6	1.28	12		
10/14/93																					2.2	0.63	12		
1/27/94																					1	0.23	12	6.28	13
2/15/94																					1.2	0.28	12	6.24	13.3
3/1/94																					0.9	0.12	12	6.36	15.7
3/14/94																					0.9	0.15	12	6.51	18.5
4/25/94																					0.7	0.15	12	6.7	17.3
4/27/94																					1	0.2	12	6.84	18
4/28/94																					1	0.25	12	6.94	16.9
5/2/94																					1	0.18	12	6.8	18.5
5/16/94																					0.9	0.18	12	7.04	17.7
5/17/94																					1.05	0.26	12	7.12	18.7
5/19/94																					1.05	0.27	12	7.05	19
5/24/94																					0.9	0.18	12	6.8	19.8
6/13/94																					0.9	0.18	12	6.91	19.6
6/14/94																					0.9	0.24	12	7.06	19.1
6/15/94																					0.9	0.24	12	7	19
6/16/94																					0.9	0.19	12	7	18.4

Utility ID: SCVWD (ACWD, CCWD, EBMUD, MWD, SCVWD)

1. Study ID: Pilot Study (Optimization Study 9/95, etc.)

2. Source water: South Bay Aqueduct - San Luis Reservoir (River, lake, groundwater, etc.)

3. Source water ID: State and Federal Water Projects (State Project water, blend of...., etc.)

5. Describe level of study: (indicate with an 'X')

	Bench-scale
X	Pilot-scale
	Full-scale

In this data sheet, "Filt." refers to data collected after coagulation, flocculation, sedimentation, and filtration.

6. Indicate with an 'X' if data reported as "Filt." are from samples collected after sedimentation only:
or after sedimentation and filtration: X

WATER QUALITY DATA: PRE-OZONE

Date	Time	TOC (mg/L)			UV-254 (1/cm)			Alkalinity (mg/L as CaCO3)			Hardness (mg/L as CaCO3) Total			Bromide (mg/L)			Ammonia (mg NH3-N/L)			Chloride (mg Cl-/L)			TDS (mg/L)			Turbidity (NTU)			pH ()			Tempera (deg.	
		Raw	Ozon.	Filt.	Raw	Ozon.	Filt.	Raw	Ozon.	Filt.	Raw	Ozon	Filt.	Raw	Ozon.	Filt.	Raw	Ozon.	Filt.	Raw	Ozon.	Filt.	Raw	Ozon.	Filt.	Raw	Ozon.	Filt.	Raw	Ozon.	Filt.	Raw	Ozon.
5/11/93		3.51		2.13				68			110			0.17		0.16							236			11		0.05	7.8	7.8	6.64	20	20
5/18/93		3.58		1.85				62		48	105		108	0.16		0.16							234		220	10		0.05	7.8	7.8	6.66	21	21
5/25/93		5.86		2.97				79		52	130		131	0.23		0.22							270		292	6			6.8	6.8		18.7	16.1
11/17/93		3.05		2.06	0.118		0.029	62		69	105		105	0.22		0.23				71			238		262	10.13		0.074	7.42		7.86	16.4	
1/4/94		3.44		1.91	0.120		0.028	64		53	103		103	0.23		0.14							235		223	2.9		0.17	7.7		6.7	13.5	
1/5/94		3.27		1.83	0.119		0.030	69		47	102		102	0.89									236		243	2.46		0.092	7.48		6.75	12.8	
1/5/94		3.27		1.09	0.119		0.018	69		56	102			0.89		0.68							236		243	2.46		0.085	7.48		6.81	12.8	
2/15/94		4.82		2.05	0.215		0.033	83			115		115	0.16		0.12							219			7.37			7.59	7.02		12.5	12.5
3/1/94		5.57		2.46	0.262		0.032	70		42	113		113	0.17		0.14							235		248	9.66		0.134	7.6	7.15	6.48	14.5	14.1
3/14/94		3.09		1.49	0.114		0.018	70		53	107		107	0.2		0.14							243		250	1.429		0.083	7.28	7.23	6.43	12.9	14.3
4/25/94		4.6		2.19	0.181		0.027	81		59	124		124	0.55	0.55	0.37				70			272		283	5.94		0.047	7.87	7.16	6.59	16.9	17
4/25/94		4.6		1.39	0.181		0.022	81		51	124		124	0.55	0.55	0.31				70			272		286	5.94		0.071	7.87	7.16	6.53	16.9	17
5/16/94		3.97		2.1	0.142		0.028	95		75	129		129	0.45	0.46	0.32				50			241		247	5.57		0.071	8.04	7.85	6.85	16.2	17.2
5/16/94		3.97		1.79	0.142		0.023	95		7	129		129	0.45	0.46	0.24				50			241		248	5.57		0.069	8.04	7.85	6.8	16.2	17.2
	Bromate Data																																
5/11/93		3.51		2.13				68			110			170		160							236			11		0.05	7.8	20	7.87	20	
5/13/93		4.17			0.028			70			113			170									241			11		0.06	7.8	20	6.3	20	
5/18/93		3.58		1.85				62		48	105		108	160		160							234		220	10		0.05	7.8	21	6.66	21	
5/19/93		3.55						63		37	111			160									233			9		0.09	7.3		6.03	22	
5/25/93		5.86		2.97				79		52	130		131	230		220							270		292	6			6.8	16.1		18.7	
5/26/93		6.56			0.043			79		5.3	131			220									285		298	8		0.1	6.8	16.2	6.7	17.3	
8/18/93		2.78			0.136			45			45									16			88.6		53	21		0.176	7.4	23.8	5.3	22.9	
8/25/93		4.13						38			38			170		140				32			46.8			15		0.05	7.3	21.5		23	
8/26/93		2.34			0.128			40		5	41			100		110				16			52.7		68.2	13		0.041	7.6	24.8	5.44	22.5	
9/1/93		2.52			0.128			43		18	48			740		530				16			58.2		66	22.8		0.02	7.47	23.7	6.07	23.7	
10/4/93		3.62			0.107			87			105			200		180		0.5		30			168		184	7.16		0.069	7.74	20	6.34	19	
10/5/93		3.56			0.109			95		54	110		110	580		540		0.5		31			173		186	7.2		0.075	7.81	18.8	6.6	18.2	
10/7/93		3.48			0.102			93		50	102		102	460		0.46		0.5		33			177		197	9.79		0.052	7.94	19.6	6.6	18.4	
10/12/93		3.67			0.106			96		22	116		116	250		250		0.5		32			178		204	5.42		0.063	7.6	18.6	5.7	18.5	
11/17/93		3.05		2.06	0.118			62		69	105		105	220		230				71			238		262	10.13		0.074	7.42		7.86	16.4	
12/6/93		3.27		1.95	0.115			68		55	103		103			160				69			244		252	1.6		0.06	7.5	16.8	6.68	16	
1/4/94		3.44		1.91	0.120			64		53	103		103	230		140							235		223	2.9		0.17	7.7		6.7	13.5	
1/5/94		3.27		1.83	0.119			69		47	102		102	890									236		243	2.46		0.092	7.48		6.75	12.8	
1/5/94		3.27		1.09	0.119			69		56	102			890		680							236		243	2.46		0.085	7.48		6.81	12.8	
1/27/94								71		45	112		112	200									241		248	11.07		0.202	7.15	12.3	6.25	11.9	
2/15/94		4.82		2.05	0.215			83			115		115	160		120							219			7.37			7.59	12.5		12.5	
3/1/94		5.57		2.46	0.262			70		42	113		113	170		140							235		248	9.66		0.134	7.6	14.1	6.48	14.5	
3/14/94		3.09		1.49	0.114			70		53	107		107	200		140							243		250	1.429		0.083	7.28	14.3	6.43	12.9	
4/25/94		4.6		2.19	0.181			81		59	124		124	550	550	370				70			272		283	5.94		0.047	7.87	17	6.59	16.9	
4/25/94		4.6		1.39	0.181			81		51	124		124	550	550	310				70			272		286	5.94		0.071	7.87	17	6.53	16.9	
4/27/94		4.67			0.168			82		58	127		127	530	540	430				73			274		287	7.97		0.056	7.64	16.9	6.77	17.1	
4/27/94		4.67			0.168			82		58	127		127	530	540	470				73			274		290	7.97		0.06	7.64	16.9	6.8	17.1	
4/28/94		4.58			0.193			81		57	126		126	550	550	533				74			280		291	8.69		0.078	7.5	16.4	6.78	16	
4/28/94		4.58			0.193			81		61	126		126	550	550	420				74			280		288	8.69		0.08	7.5	16.4	6.77	16	
5/2/94		4.56			0.161			81		63	127		127	560	570	570				72			281		289	5.34		0.081	8.13		6.67	17.6	
5/2/94		4.56			0.161			81		60	127		127	560	570	480				72			281		288	5.34		0.089	8.13		6.6	17.6	
5/16/94		3.97		2.1	0.142			95		75	129		129	450	460	0.32				50			241		247	5.57		0.071	8.04	17.2	6.85	16.2	
5/16/94		3.97		1.79	0.142			95		7	129		129	450	460	0.24				50			241		248	5.57		0.069	8.04	17.2	6.8	16.2	
5/17/94		3.79			0.155			81		61	120		120	530	560	0.52				69			266		277	4.92		0.042	8.71	18.3	6.97	18.5	
5/17/94		3.79			0.155			81		62	120		120	530	560	0.47				69			266		277	4.92		0.053	8.71	18.3	7.03	18.5	
5/19/94		3.86			0.141			85		71	120		120	500						69			261		271	5.4		0.092	8.56	18.7	7.05	18.5	
5/19/94		3.86			0.141			85		70	120		120	500						69			261		271	5.4		0.089	8.56	18.7	6.98	18.5	
5/24/94		3.89			0.136			89		75	128		128	670	550	0.5				54			236		246	6.84		0.051	8.12	19	6.82	16.8	
5/24/94		3.89			0.136			89		75	128		128	670	550	0.43				54			236		247	6.84		0.054	8.12	19	6.89	16.8	

D-042272

Utility ID:																												
1. Study ID:																												
2. Source wa																												
3. Source wa																												
5. Describe l																											Indicate coagulants stu	
(indicate wit																											ID	Coagulant
																											1	Alum
																											2	Ferric Chlo.
																											3	
6. Indicate w																											4	
WATER Q																											TREATMENT CONDI	

Date	re	Bromate (µg/L)			HPC (CFU/mL)			Chlorination conditions Filtered								Disinfection By-products TTHM (µg/L)			HAA5 (µg/L)			HAA6 (µg/L)			Coagulant ID	Coagu Dose
	Filt.	Raw	Ozon.	Filt.	Raw	Ozon.	Filt.	Indicate disinfectant(s) used with an 'X' chlorine	chloramine	Chlorine dose (mg Cl2/L)	Ammonia dose (mg NH3-N/L)	Incubation time (h) chlorine	chloramine	Incub. temp. (deg. C)	pH ()	Residual (mg Cl2/L)	Raw	Ozon.	Filt.	Raw	Ozon.	Filt.	Raw	Ozon.	Filt.	(see above)	
5/11/93	21.5		4.1	5.3			13851	X	X	2.5	0.67	0.083	168	20-25	6.94	2.01			19			21.01			40.01	2	20
5/18/93	22.2		16.3	13.5			192	X	X	2.5	0.69	0.083	168	20-25	6.84	2.07			9			11.07			20.07	2	20
5/25/93			18.7	13.3			5700	X	X	2.5	0.70	0.083	168	20-25	6.4	2.1			16			18.1			34.1	2	30
11/17/93	17.8			13.7				X	X		0.00	0.000	168	20-25	8	0			1			1			2	2	25
1/4/94	16.1			5.8			1400	X	X		0.33	0.083	168	20-25	6.7	1						1			1	2	15
1/5/94	15.5			14.5			15390	X	X		0.33	0.083	168	20-25	6.8	1			56.5			57.5			114	2	
1/5/94	15.5			14.4			14250	X	X		0.33	0.083	168	20-25	6.7	1			38.5			39.5			78	2	
2/15/94			2.4	5.3	820		5700	X	X	2	0.50	0.083	168	20-25	6.3	1.5			23			24.5			47.5	2	30
3/1/94	16.7		2	2.4	2100		1900	X	X	2	0.78	0.083	168	20-25	6.48	2.35			23			25.35			48.35	2	40
3/14/94	20.2		7.5	6.8			4200	X	X	2	0.53	0.083	168	20-25	6.43	1.6			21			22.6			43.6	2	26
4/25/94	17.6		10.5	9.64	81		860	X	X	2	0.52	0.083	168	20-25	6.59	1.55			46			47.55			93.55	2	21.5
4/25/94	17.5		10.5	6	81		3100	X	X	2	0.43	0.083	168	20-25	6.53	1.3			30			31.3			61.3	2	21.5
5/16/94	18.7		16.5	13.6	1500		1900	X	X	2	0.51	0.083	168	20-25	6.65	1.52			37			38.52			75.52	2	21
5/16/94	18.2		16.5	7.1	1500		2400	X	X	2	0.52	0.083	168	20-25	6.8	1.55			32			33.55			65.55	2	21
5/11/93	21.5		4.1	5.3																						2	20
5/13/93	20		12.1																							2	20
5/18/93	22.2		16.3	13.5																						2	20
5/19/93	22.9		20																							2	20
5/25/93			18.7	13.3																						2	30
5/26/93	17.3		16																							2	5.3
6/18/93	24.9			1																						2	20
8/25/93				4.2																						2	10
8/26/93	27.5			3.8																						2	10
9/1/93	26.5			13.8																						2	20
10/4/93	19.7			2.4																						2	20
10/5/93	19.5			11.1																						2	20
10/7/93	20.9			12																						2	20
10/12/93	20.7			1																						2	20
11/17/93	17.8			13.7																						2	25
12/8/93	17.4			69.7																						2	15
1/4/94	16.1			5.8																						2	15
1/5/94	15.5			14.5																						2	
1/5/94	15.5			14.4																						2	
1/27/94	15			3.3																						2	25
2/15/94			2.4	5.3																						2	30
3/1/94	16.7		2	2.4																						2	40
3/14/94	20.2		7.5	6.8																						2	26
4/25/94	17.6		10.5	9.64																						2	21.5
4/25/94	17.5		10.5	6																						2	21.5
4/27/94	18.3		6.6	6.9																						2	21
4/27/94	18.4		6.6	6.2																						2	21
4/28/94	18.1		7.6	6.5																						2	22
4/28/94	18.2		7.6	3.3																						2	22
5/2/94	18.8		5.4	5																						2	22
5/2/94	18.7		5.4	2																						2	22
5/16/94	18.7		16.5	13.6																						2	21
5/16/94	18.2		16.5	7.1																						2	21
5/17/94	19.5		6.3	4.3																						2	21
5/17/94	19.5		6.3	3.3																						2	21
5/19/94	19.7		20.4	16.8																						2	21
5/19/94	19.6		20.4	17.5																						2	21
5/24/94	20.9		7.3	6.1																						2	25
5/24/94	20.5		7.3	3.1																						2	25

Utility ID:									
1. Study ID:									
2. Source wa									
3. Source wa									
	ed:								
5. Describe I	Chemical formula		Units						
(indicate wit	Al2(SO4)3		mg/L						
	FeCl3		mg/L						
6. Indicate w									
WATER Q IONS									
Date	tion Conditions				Ozonation Conditions				
	Acid adjusted? (Y/N)	Base adjusted? (Y/N)	Coag. pH ()	Coag. temp. (deg. C)	Ozone dose (mg/L)	Ozone residual (mg/L)	Contact time (min)	Ozone pH ()	Ozone temp. (deg. C)
5/11/93			6.64	19.7	3	0.43		7.8	20
5/18/93			6.73	22.2	4	0.52		7.8	21
5/25/93					5.3	0.71	18.36	6.8	16.1
11/17/93			7.68	17.7	3	0.43	12.24		
1/4/94			7.15	14.5	1.5	0.18	12.24		
1/5/94			6.78	14.2			12.24		
1/5/94			6.72	14.4	1.8	0.36	12.24		
2/15/94			6.3	12.7	3.1	0.32	12.24	7.02	12.5
3/1/94			6.36	15.2	3.4	0.48	12.24	7.15	14.1
3/14/94			6.51	15.7	2.3	0.45	12.24	7.23	14.3
4/25/94			6.63	17.3	3.5	0.57	12.24	7.16	17
4/25/94			6.63	17.3	3.5	0.57	12.24	7.16	17
5/16/94			7	17.5	2.5	0.4	12.24	7.85	17.2
5/16/94			7	17.5	2.5	0.4	12.24	7.85	17.2
5/11/93			6.64	19.7	3	0.43	18.36	7.8	20
5/13/93			6.29	20	3.1	0.85	18.36	6.5	20
5/18/93			6.73	22.2	4	0.52	18.36	7.8	21
5/19/93			6.04	23	4.7	1.3	12.24		
5/25/93					5.3	0.71	18.36	6.8	16.1
5/26/93			6.65	17.2	6.5	0.45	18.36	7	16.2
8/18/93			5.43	24.5	1.9	0.3	12.24	5.94	23.8
8/25/93			5.4	25.9	2.9	0.45	12.24	6.3	21.5
8/26/93			4.21	26.1	3.6	1.31	12.24	5.95	24.8
9/1/93			6.32	25.4	2.4	0.46	12.24	7.47	23.7
10/4/93			6.45	19.6	1.5	0.24	12.24	6.45	20
10/5/93			6.56	19.2	1.5	0.23	18.36	7.04	18.8
10/7/93			5.57	19.8	3.1	1.07	12.24	6.99	19.6
10/12/93			5.52	19.9	1.2	0.12	12.24	6.01	18.6
11/17/93			7.68	17.7	3	0.43	12.24		
12/8/93			6.6	17	5	1.29	12.24	7.56	16.8
1/4/94			7.15	14.5	1.5	0.18	12.24		
1/5/94			6.78	14.2			12.24		
1/5/94			6.72	14.4	1.8	0.36			
1/27/94			6.18	13.4	3.2	0.47	12.24	7.18	12.3
2/15/94			6.3	12.7	3.1	0.32		7.02	12.5
3/1/94			6.36	15.2	3.4	0.48	12.24	7.15	14.1
3/14/94			6.51	15.7	2.3	0.45	12.24	7.23	14.3
4/25/94			6.63	17.3	3.5	0.57	12.24	7.16	17
4/25/94			6.63	17.3	3.5	0.57	12.24	7.16	17
4/27/94			6.82	17.1	4.85	0.5	12.24	7.32	16.9
4/27/94			6.82	17.1	4.85	0.5	12.24	7.32	16.9
4/28/94			6.85	17	3	0.62	12.24	7.63	16.4
4/28/94			6.85	17	3	0.62	12.24	7.63	16.4
5/2/94			6.85	18.1	2.9	0.27	12.24		
5/2/94			6.85	18.1	2.9	0.27	12.24		
5/16/94			7	17.5	2.5	0.4		7.85	17.2
5/16/94			7	17.5	2.5	0.4	12.24	7.85	17.2
5/17/94			18.8	6.97	2.5	0.36	12.24	8.4	18.3
5/17/94			18.8	6.97	2.5	0.36	12.24	8.4	18.3
5/19/94			7.19	19.1	2.6	0.27	12.24	8.35	18.7
5/19/94			7.19	19.1	2.6	0.27	12.24	8.35	18.7
5/24/94			6.86	19.8	2.2	0.27	12.24	7.5	19
5/24/94			6.86	19.8	2.2	0.27	12.24	7.5	19
							12.24		